MicroComputer JOURNAL

The print forum for the MicroComputer professional and semi-professional

January/February 1995

68HC11 Controller & Languages

Program it in C

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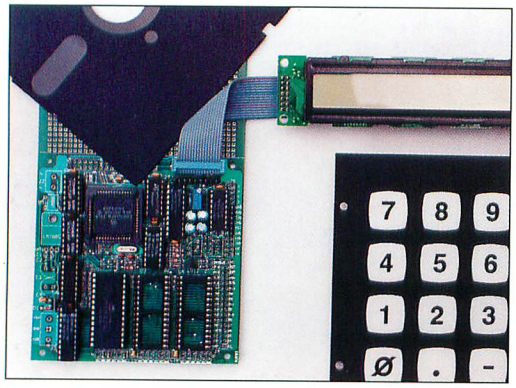

or Assembly

or FORTH

or Basic

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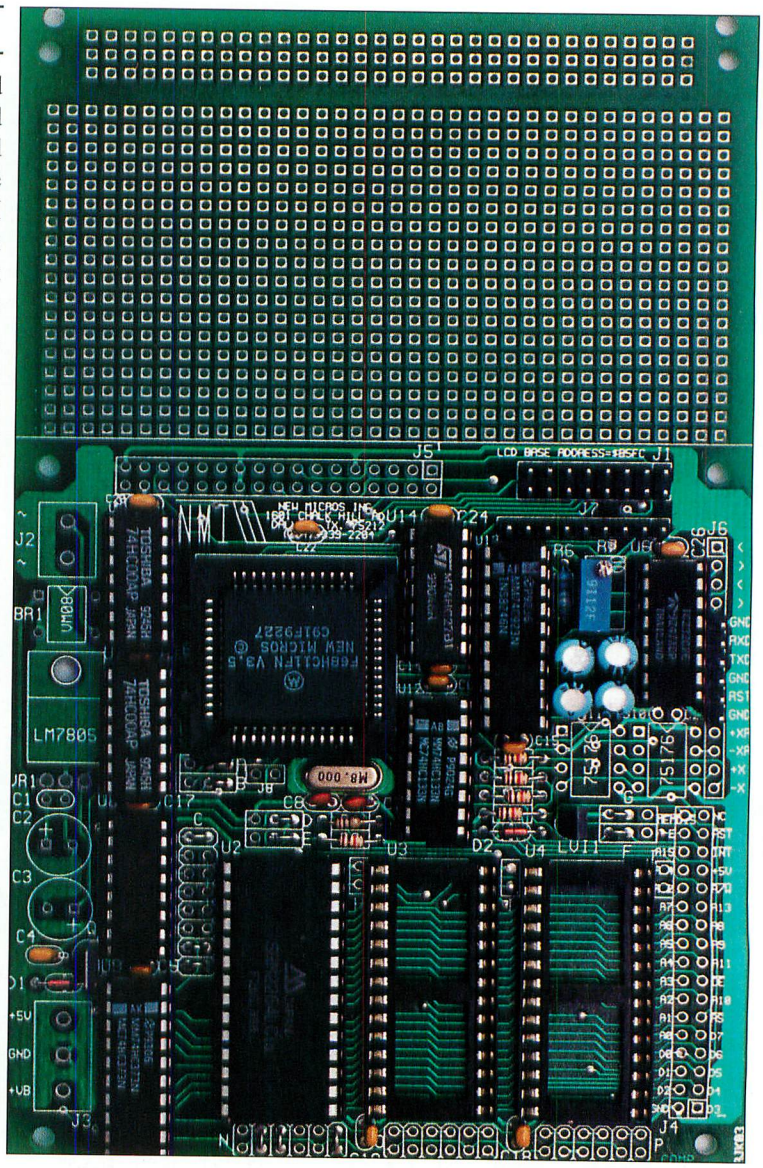
Languages supplied on accessory disk: Small C, Basic, and Assembler. FORTH resident on chip (may be disabled). Languages come with manuals on disk. (Printed manuals extra.) Communications utility, MAXTALK included to allow PC clone to act as terminal for download and development. WIPE utility included allows internal ROM, EEPROM, WDT to be enabled/disabled, and EEPROM to be erased. Manuals on disk: UM-MAX Max-FORTH Users Manual, HM-20 NMIX-0020 Hardware Manual, Small C manuals with examples, BASIC11E9 Manual.

SBC and utility disk - $99. (Keypad and LCD not included. Available separately.) Great value. Call today! New Micros, Inc. Tel: 214-339-2204, Fax: 214-339-1585.



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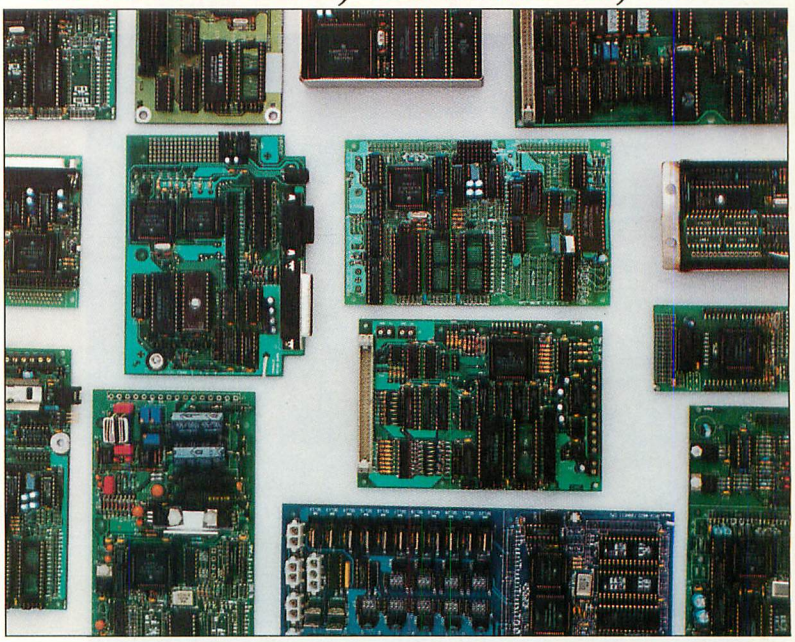

These controllers have been quite a hit. Thousands have been sold, just as seen in the picture on the facing page. Did you know, these boards *can* be customized?

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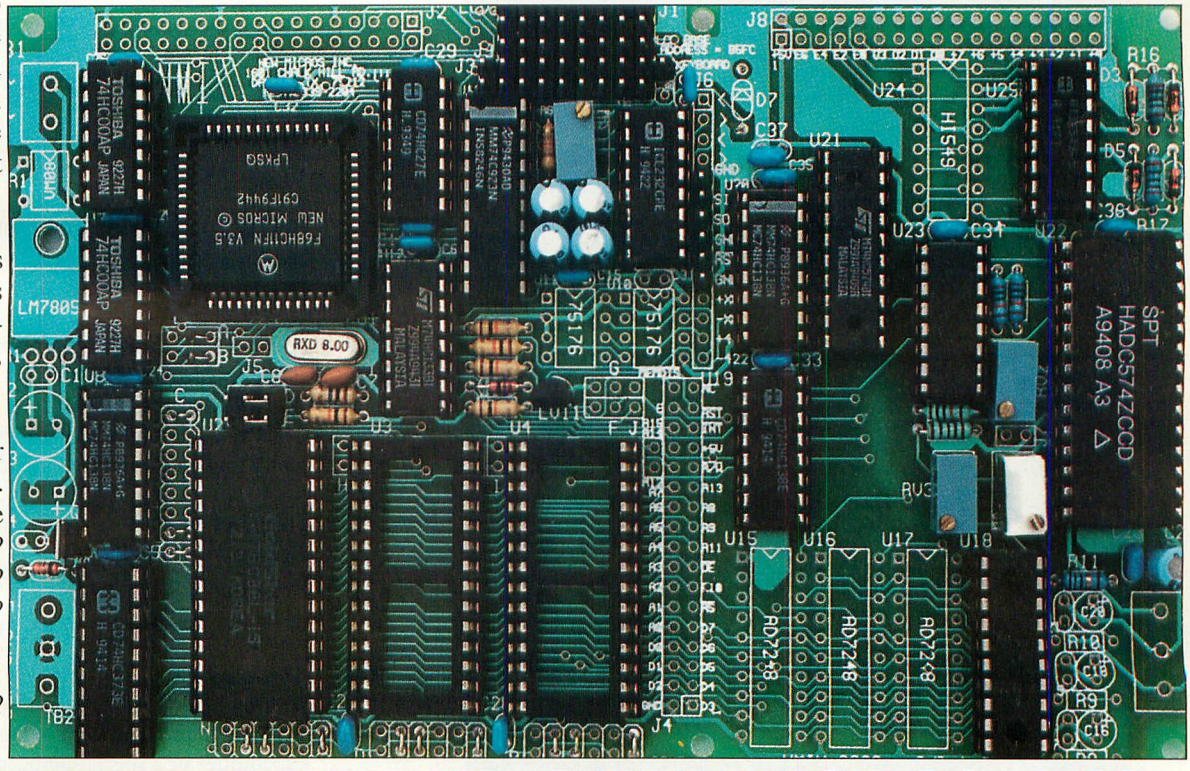

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CIRCLE NO. 81 ON FREE INFORMATION CARD

MicroComputer JOURNAL

Volume 2, No. 1, January/February 1995

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Features

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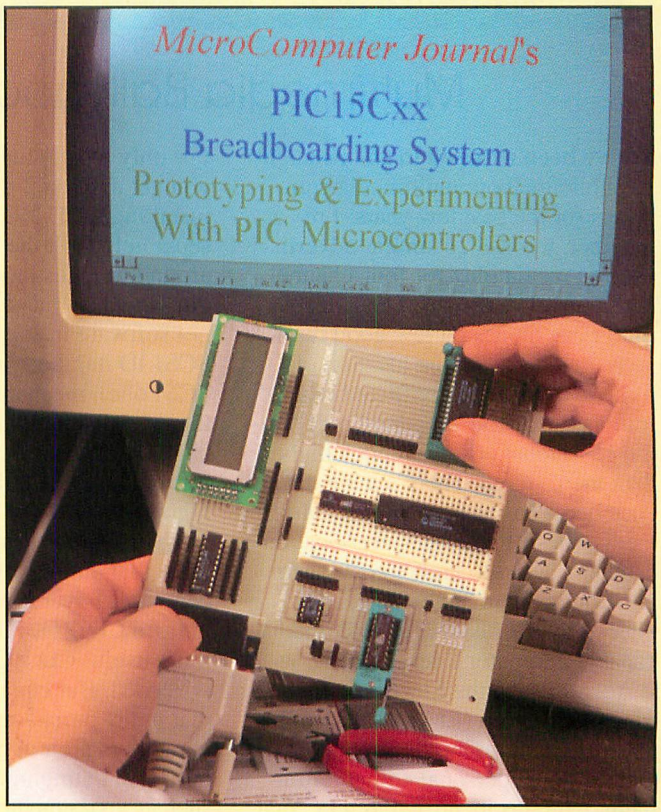
In This Issue

Now that PIC microcontrollers have become almost mainstream on the computing front, you'll want to check out Fred Eady's PIC16Cxx Breadboarding System, pictured on the cover of this issue. Described in the article beginning on page 15, it details how to begin prototyping and experimenting with PIC-based circuits. It has all you need to get you started in a convenient, efficient manner. If you have more than one computer at home, another article you'll certainly want to read closely is David F. Norman's "Enhancing Home Productivity With a Network. " Beginning on page 24, it shows how to set up your own inexpensive local LAN with Artisoft's *Simply Lantastic*.

As you thumb further through this issue, Paul Bergsman illustrates how to use your PC to measure a variety of physical parameters (page 28), Hardin Brothers puts you on the inside track to the world of "Fuzzy Logic" (page 36) and TJ Byers' "Video Monitors: The Big Picture" (page 41) gives you considerable information



about this important element in your computer system. It will help you make an intelligent decision when it comes time to buy a new one.

Jan Axelson is back with Part 2 of "Serial Ports Inside and Out" (page 50), this time taking you on a tour from the connector out. Then, beginning on page 59, Phil Hughes offers you an alternative to DOS and *Windows* with the Unix-like Linux multi-tasking development platform for PC/compatibles. You can download it for just the cost of a call to a BBS that has it.

Beginning on page 64, we offer reviews of three products worthy of serious consideration. We begin with Tom Fox's in-depth report on the powerful *Mathcad* 5.0 software program. Next comes Leslee Jo Sebastian's review of the *LapLink V* program, which lets you effortlessly transfer files from one PC to another via their serial ports. Finally, SF Sparrow installs SCSI devices with Future Domain's PowerSCSI! hardware/software package.

Tom Benford has some "Great Products For Multimedia" (page 77) to which you might want to give serious consideration to round out your PC setup. Then Ted Needleman (page 82) has a trio of new programs that have you folding and flying paper airplanes, adding emphasis to any *Windows*-based application, re-sizing and resampling image files and having fun manipulating images. Joe Desposito gives you the low-down on adding a device to your desktop PC that will let you use PCMCIA devices (page 87) and Yacco discusses some of *Windows*' trials and tribulations and how to cure them (page 90). He then continues his tour of the Internet information superhighway begun last issue. Rounding things out, TJ Byers solves more reader problems (page 96), and John Hastings gives you the latest news on the PC front and representative examples of prices for used computer equipment.

Cover Photo By Larry Mulvehill

MicroComputer Journal on MCI Mail

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Editorial By Art Salsberg

Multimedia Ballyhoo

We've been exposed to an onslaught of publicity about multimedia computers for the past few years. I remember, too well, a similar advertising and media blitz for four-channel audio many years ago. The latter didn't catch on for a few good reasons, among them, the location of more speakers that conflicted with a room's decor and "quadraphonic" audio equipment cost was much higher than mere stereo. There's a big difference between the two, though. Multimedia doesn't present space/location problems. Nor do higher costs seem to be deterring many people, as evidenced by the fast rise of multimedia-capable computer sales.

According to the Electronic Industries Association (EIA), for example, 8% of U.S. households already have a multimedia personal computer in them, which is identified as a PC that has speakers, sound card and a CD-ROM drive. And a new study from SIMBA Information, Inc., "Economics of Multimedia Title Publishing," states that the number of multimedia-capable PCs will rise by about 10-million, to more than 17-million by the end of 1995. The study also predicts that Microsoft's Multimedia PC (MPV) platform will account for nearly two-thirds of all multimedia PCs, leaving Apple Macintosh with nearly another third.

The CD-ROM drive, at the heart of a multimedia system, is going great guns. The EIA report notes that CD-ROM penetration has reached 18% of PC households and could rise to 34% by the end of 1995! Interestingly, the survey, performed by The Verity Group Inc., indicates that men are nearly twice as likely to use separate stereo speakers with their PCs. Furthermore, a Dataquest survey indicates that CD-ROM sales are expected to hit 50-million in 1996.

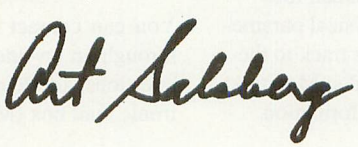
There's still plenty of confusion in the marketplace about just what multimedia is and what it offers the user, however. Dataquest observes that about 78% of CD-ROM drives sold in 1994 were "bundled" with PCs. That is, the CD-ROM drives were already built into the PCs. This makes for easier multimedia sales, of course. For only X amount of dollars more you get dah! dah! dah! Additionally, installing a CD-ROM drive bought separately isn't the easiest task around. It takes more than just plugging in a host adapter card. You've got software installation, selecting SCSI ID numbers (if the drive is an SCSI one), mechanical installation of the drive itself, address selection, choosing the correct interrupt and testing the system. It could be a nightmare!

The Dataquest survey also indicates that almost 40% of multimedia computer buyers never even use their built-in CD-ROM drives. Apparently, more useful CD-ROM disk material is needed. But equally important is that many purchasers of multimedia computers aren't up to the challenges of manipulating multiple elements, such as text, graphics, audio and video.

Moreover, many so-called multimedia computers are painstakingly slow in operation. A 3x- or 4x-speed CD-ROM drive won't give you the boost you wish if your CPU isn't sufficiently powerful, if your bus is limited or memory is inadequate—not if you wish to go beyond games or reading text to real-time audio and video compression and decompression and imaging.

Keep in mind that even quad-speed CD-ROM drives are much slower than hard-disk drives. They're more on a par with floppy-disk drives. So if you're really serious about utilizing CD-ROM applications, you should weigh the types of multimedia work you hope your machine will perform. Would you require a 64-bit accelerator? Or perhaps a special software program designed expressly to greatly speed up CD-ROM data searches? One of the latter, *d-Time*[10]from Ballard Synergy (tel.: 206-656-8070), claims that its $70 program reduces CD-ROM database searches from 20 minutes to one minute.

So tread warily when entering PC multimedia. It's still on the primitive side for truly serious work.



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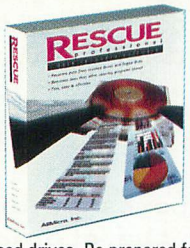

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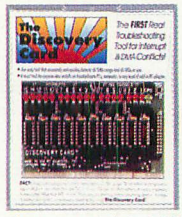

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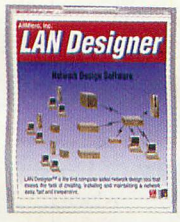

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DELL TOUTS EXTENDED BATTERY LIFE. Dell Computer's new Latitude XP family of notebook computers includes new "smart" battery technology and advanced power-management features that's claimed to deliver 30% longer battery life than the current industry leader—nearly five hours of continuous run time and 17 hours of light-use operating time. Test results by Veritest, Inc., Santa Monica, CA, were performed on a Dell XP50 passive-matrix color notebook. The active-matrix Dell XP100 averaged close to 3.5 hours of continuous use, also said to be a record for active-matrix notebooks. In contrast, mono machines typically run just under three hours in continuous use, which represents intensive operation with most power management disabled, including screen and hard disk time-outs. The new battery packs are lithium-ion (LISB) types. They contain a built-in controller to monitor the battery's condition and provide accurate charge readings on a Windows-based pop-up battery gauge. The battery also has a five-step LED charge gauge on its body.

HIGHER-DENSITY DISKS. Fuji Photo Film reports it created a high-density recording medium that more than quadruples the storage capacity of 3.5" floppy disks from the current 21M to more than 100M! The industry standard 3.5" diskette stores only 2M of data. Moreover, Fuji claims a dramatic increase in data-transfer rate of more than 2M/second, which is on a par with a hard-disk drive.

Epson introduces the industry's highest density hard-disk PCMCIA card, its Model EHDD170 credit-card-sized drive. It's a 1.8" 170M drive for use in any Type III PCMCIA slot. It lists for $629. For more information, call 1-800-289-3776.

ROBOT CONTEST. The Connecticut Robotics Society is sponsoring its second international robot contest in April 1995. It's open to everyone and has different categories of age, ability and experience level. The challenge is to build a robotic device that can move through a model of a single floor of a house, look for fire (a lit candle) and then extinguish it. Contestants will be given the house's exact layout and official rules. The shortest time wins, of course. Robots must be less than one-foot on a side and can be tethered to a personal computer or controlled by an internal microprocessor.

Entrants in last year's all-day contest ranged from MIT professors to fourth graders. For more information, contact Jake Mendelssohn at 203-233-2379 or on Prodigy: KJRP71A or Internet: jake.mendelssohn@circellar.com

COMPUTER VIRUS GUIDE. A 20-page booklet titled "How to Avoid Computer Viruses" is packed with detailed questions and answers, tables and charts, about computer viruses. It contains information on coping with boot-sector and file-infecting viruses, understanding logic bombs, time bombs, Trojan horses and worms, how to ensure that new diskettes are virus-free, how virus behavior varies from PCs to Macs, and much more. The National Computer security Association and 3M have joined to offer the booklet for $2. Mail a check with your name and address on a 3" X 5" card to 3M Virus Brochure, PO Box 8031, Young-America, MN 55551-8031. It's also available on two on-line services without tables and charts: The Computer Security Forum on CompuServe (GONCSA) and on Delphi (access through Computing Menu). Also, there's a dedicated HELP desk provided by NCSA for tech support to users who think their computers may have been infected. The service costs $1.95 per minute, Monday through Friday from 9 to 5 pm Eastern time. Call 900-555-6272.

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***Pow-R-Bar*™ is an intelligent, user-configurable, six outlet power center which operates on RS-232 protocol with a computer's serial port to provide individual on/off control over each of the six outlets.**

Pow-R-Bar™ is the perfect solution for controlling multiple AC outlets. With *Pow-R-Bar*™ connected to a computer, each outlet is controllable through the computer's serial port using industry standard RS-232 protocol. Each outlet can be turned on/off from the computer, by typing in a simple command or through custom programming.

Up to 26 *Pow-R-Bar*™s can be daisy chained together providing up to 156 outlets individually controllable from a single computer. With the included demonstration software, each *Pow-R-Bar*™ can be individually labeled, and each outlet can be individually named. The *Pow-R-Bar*™s are individually plugged into a 110v AC outlet and linked together by serial cable up to 50 feet apart. With up to 26 *Pow-R-Bar*™s daisy chained together, each as much as 50 feet apart , you can control up to 156 outlets through a daisy chain of up to 1300 feet (virtually unlimited distance when using modems). With this system, considerable AC control is available to a user at a computer's keyboard. Stage productions can be computer controlled. Homes or offices can be automated. Remote location file servers can be rebooted. You can turn on an AC device from your keyboard with a few keystrokes.

When used with our sensing devices, such as *Temp-A-Chip*™ *II*, *Pow-R-Bar*™ is part of a very extensive environmental monitoring system. The sensors provide environmental condition input, programming in the computer reacts to the data and activates the outlets in *Pow-R-Bar*™ to turn on AC devices. *Pow-R-Bar*™ is AC control made easy enough for anyone to use.

Specifications

- Each unit has six individually controllable outlets on the back with easy to read LEDs on the front indicating that AC is on/off for each outlet.
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Hardware

PC Printer Sharing

ParaShare II, a printer-sharing device from Belkin Components, services four printers using an exclusive six-wire cable system. A *Windows* icon or DOS hot-keys are used to select the printer of your choice. With ParaShare II, as many as 40 users can share four parallel printers. The device can be used with any parallel printer and supports transmission distances up to 1,200 feet. $74.99, Starter Kit. *Belkin Components, 1303 Walnut Park Way, Compton, CA 90220; tel.: 310-898-1100; fax: 310-898-1111.*

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Telephone/ PC Link

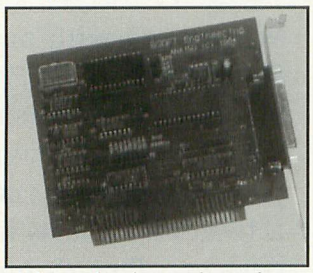
Clearwave Communications' Intellect telephone/PC link automatically organizes all desktop communications. It combines a single piece of external hardware with software that integrates telephone, fax machine, modem, computer, voice mail and answering machine into a communications command center. All incoming and outgoing communications are instantly organized for easy retrieval and reference. Intellect gives a single phone line multiple destinations and performs its functions, whether or not the PC is turned on or even connected.

Using Caller ID, Intellect captures such essential information as names and phone numbers and can automatically load contact information into popular PIMs, contact managers and databases. Battery back-up provides uninterrupted use during power failures, a note pad feature allows for instant note taking, a built-in speaker gives hands-free listening and a sort function provides organization of messages by name, date and subject. *Clearwave Communications, Inc., 1330 Glen Haven, Ste. 300, Ft. Collins, CO 80526; tel.: 303-223-3873; fax: 303-223-0418.*

CIRCLE NO. 2 ON FREE CARD

Analog/Counter Board

BSoft's ANA150 eight-bit data-acquisition board for PC-compatible computers features



eight analog input channels and three individual 16-bit counters. Each board comes with a disk of programming examples written in *QuickBASIC* for controlling the ANA150. *PC-SCOPE*, a PC-based digital storage oscilloscope software program, is bundled with the board. $99. *BSoft Software, Inc., 444 Colton Rd., Columbus, OH 43207; tel.: 614-491-0832; fax: 614-497-9971.*

CIRCLE NO. 3 ON FREE CARD

Universal Computer Interface

Micro-Lab from Fisher Instruments is a universal computer interface intended to be a design aid for engineers, experimenters and students. Micro-Lab functions with virtually any computer through the RS-232 port. The package includes a solderless breadboard, function generator, D/A and A/D converters, several fixed and programmable clocks, a counter, input and output ports, and audio amplifier and speaker. Sample applications and graphics drivers are also provided. $249.95. *Fisher Instruments, 20611-E Bothell-Everett Hwy., Ste. 232, Bothell, WA 98012; tel.: 206-489- 9153.*

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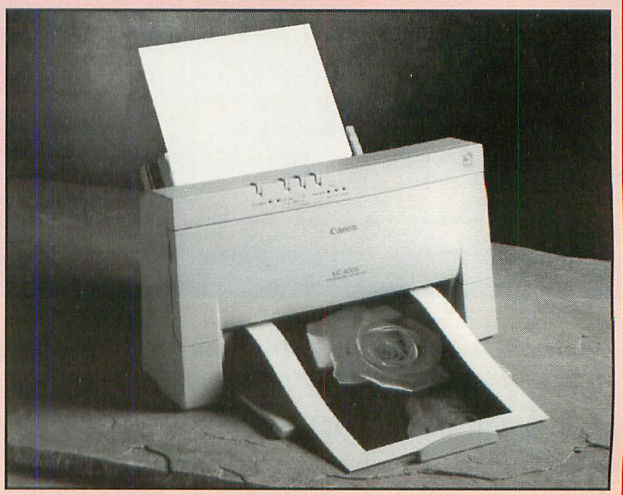


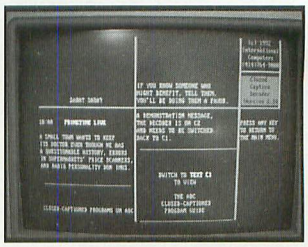
Bubble-Jet Printer

Canon's new BJC-4000 Bubble Jet printer uses an inkjet printer to print monochrome images at 720 X 360 dpi and color at 360 X 360 dpi. The printer prints up to five pages per minute and features 20 scalable *TrueType* fonts and seven resident bit-mapped fonts. A built-in automatic sheet feeder handles up to 100 sheets of paper or 15 envelopes at a time. $549. *Canon Computer Systems, Inc., 2995 Redhill Ave., Costa Mesa, CA 92626; tel.: 800-848- 4123.*

CIRCLE NO. 5 ON FREE CARD

Closed-Caption Decoder

The International Computers PC-compatible Closed Caption Decoder add-in card is capable of acquiring closed captions from a television signal plugged into it and displaying the captions on a computer



screen. Captions can be saved to a file or printed. $89. *International Computers, 12021 W. Bluemound Rd., Wauwatosa, WI 53226; tel.: 414-764-9000; fax: 414-281-3522.*

CIRCLE NO. 6 ON FREE CARD

Voice/Data/Fax Modem

The CalCom Products 1442VF internal voice-interactive data/fax modem combines a 14,400-bps send/receive fax and 14,400-bps data modem with voice recognition. An auto-detect capability distinguishes between incoming faxes and voice messages. The 1442VF records, saves and plays back messages that can be accessed by one or two users. $199. *CalCom Products, 181 W. Orangethorpe, Ste. A, Placentia, CA 92670; tel.: 714-961-1888.*

CIRCLE NO. 7 ON FREE CARD

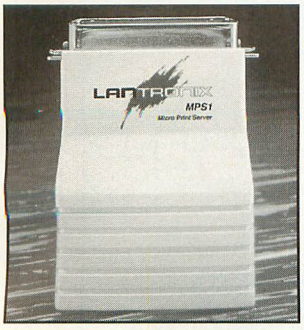
Quad-Speed CD-ROM Drive

Toshiba's XM-3501 quad-speed CD-ROM drive sports a 120-ms random seek rate and 600K/s sustained transfer rate. The drive features a SCSI-2 interface, synchronous data transfer at up to 4.2M/s second, digital audio transfer and a 256K data buffer. $470/ $600, internal/external. *Toshiba America Information Systems, Inc., Disk Products Div., 9740 Irvine Blvd., Irvine, CA 92718; tel.: 714-457-0777.*

CIRCLE NO. 8 ON FREE CARD

Print Server

The Lantronix MPS1 is a very small single-printer print server compatible with five network protocols: IPX, TCP/IP,



LAT, AppleTalk, and NetBIOS/NetBUEI. The device can service multiple print jobs using any of these protocols. It also supports HP Bitronics mode operation and is SNMP-compatible.

Two versions are available. Both provide a single Centronics-compatible parallel printer port and plug directly into the printer. The MPS1-2 has a 10-Base2 network connector, while the MPS1-T has a 10-Base-T connector. The units are Flash ROM-based for easy software upgradeability. $399. *Lantronix, 15353 Barranca Pkwy., Irvine, CA 92718; tel.: 714-453-3990; fax: 714-453-3995.*

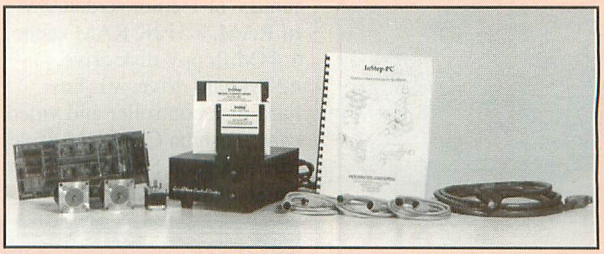
CIRCLE NO. 9 ON FREE CARD

Sound Card/ CD-ROM Controller

Omni Labs' AudioMaster 32 16-bit wavetable/FM sound card comes with a five-mode CD-ROM controller. The card features 2M of sound samples stored in ROM for the General MIDI wavetable synthesizer. A MIDI/joystick port can control up to two joysticks. Also provided are both an on-board stereo 4-watt power amplifier and a line-level audio output.

The card supports a variety of CD-ROM drives with connectors for Sony, Mitsumi, Matsushita, OmniLabs CDX-262 and IDE on one card. Sequencing, sound mixing and other software are bundled with the product. $199. *Omni Labs, 785 Market St., Ste. 1100, San Francisco, CA 94103; tel.: 415-512-2638; fax: 415-512- 2636.*

CIRCLE NO. 10 ON FREE CARD



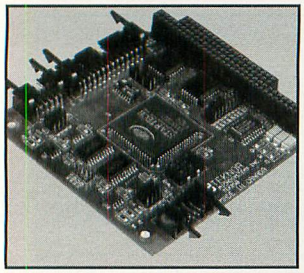
Motion-Control System

MicroKinetics' QuickPhase Engineering Evaluation Package is a three-Axis motion-control system. The package includes a QuickPhase motion-control card, QuickPhase control center, Instep motion-control software library, your choice of three stepper motors and all required cables. $495. *MicroKinetics Corp., 1220-J Kennestone Circle,, Marietta, GA 30066; tel.: 404-422-7845; fax: 404-422-7854.*

CIRCLE NO. 19 ON FREE CARD

386SX/486SLC SBC

Teknor Microsystems' VIPer-804 33-MHz 386SX/486SLC half-size PC/AT industrial single-board computer utilizes a PC/104 mezzanine bus and

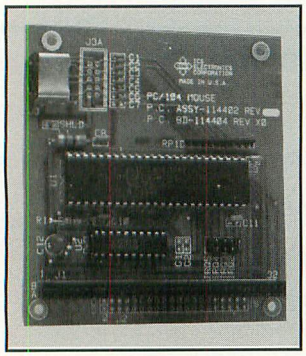


drives up to four slots on ISA passive backplanes. An SMC combination I/O chip provides IDE, keyboard and floppy-disk controllers, and one parallel and two serial ports. $795/$895, 486SX/486SLC. *Teknor Microsystems, Inc., 616 Cure Boivin, Boisbriand, Quebec, Canada J7G 2A7; tel.: 514-437-56682; fax: 514-437-8053.*

CIRCLE NO. 11 ON FREE CARD

Embedded Mouse

ICS Electronics' PC/104 Mouse Board bus mouse board has on-board jumpers that let you select IRQ levels 2 through 5. The board includes a nine-



pin mini-DIN connector for direct connection to a three-button mouse. The PC/104 is shipped with a Logitech three-button bus mouse and driver. $150. *ICS Electronics Corp., 473 Los Coches St., Milpitas, CA 95035; tel.: 408-263- 5500.*

CIRCLE NO. 12 ON FREE CARD

IPortable Pentium Multimedia PC

The Regal/Multimedia/P90 from MicroExpress is a 90-MHz Pentium-based portable PC that features a 10" active-matrix TFT color screen, 8M of RAM, a 512K RAM cache, 1.44M floppy-disk drive, 420M hard drive, VL-bus hard-disk controller and video card, Toshiba CD-ROM drive, Media Vision Spectrum 16 sound card, powered stereo

speakers, DOS 6.21 and *Windows* 3.1. Standard ports are one parallel and two serial, plus a port for an external CRT. There are three expansion slots, two 16-and one eight-bit bus slots and detachable keyboard. The system weighs about 20 lb. $5,699. *Micro Express, 1801 Carnegie Ave., Santa Ana, CA 92705; tel.: 714-852-1400; fax: 714-852-1225.*

CIRCLE NO. 13 ON FREE CARD

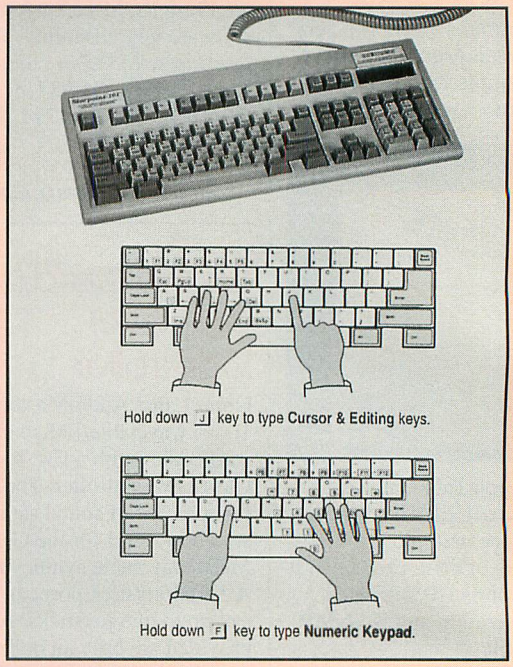
n-Home LAN

TecSystem from U.S. Tech is a home wiring system that lets you network computers, security systems and other electronic products. Consisting of a patented wall-plate, central electronic server and special networked cabling, it gives homeowners access to cable TV, telephone and electricity from a single wall source. TecSystem is CEBus-compatible and comes in multiple configurations, including four, eight and 32 networked TecPlates. $500/$1,500, four/eight TechPlates. *U.S. Tec, 470 S. Pearl St., Canandaigua, NY 14424; tel.: 716-396-9860; fax: 716-394-7095.*

CIRCLE NO. 14 ON FREE CARD

Mouse Platform

Ring King Visible's Easy Reach Mouse Platform is an ergonomic device for mouse users designed to fit on top of a standard box drawer. The device positions the mouse next to the user's side. A removable

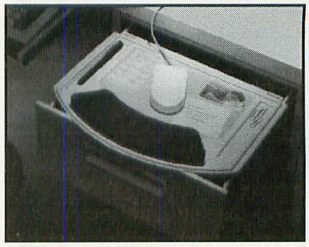


Innovative Keyboard

The Jefferson Computer Products Starpoint-101 keyboard lets a typist perform all keyboard operations while keeping both hands on the letter keys in the traditional touch-typing position. Yet it doesn't interfere with normal typing. When you hold down the J key with your right hand, the letter keys under your left hand become cursor and editing keys. When you hold down the F key with your left hand, the letter keys under your right hand become a numeric keypad.

The keyboard also features a new kind of pointing device for *Windows* users. With Menu Mouse, the spacebar can be used to open pull-down menus and select menu items. $129.95. *Jefferson Computer Products, Inc., 23454 25 Ave. S., Seattle, WA 98198; tel.: 206-824-1111; fax: 206-824-0941.*

CIRCLE NO. 15 ON FREE CARD



wrist rest places the hand about 1/2" above the base of the mouse. A removable textured Lexan sheet provides a surface for mouse movements and lifts off to store messages, notes and photographs beneath its transparent surface. $19.95. *Ring King Visibles, Inc., 2210 Second Ave., PO Box 599, Muscatine, IA 52761; tel.: 319-263-8144; fax: 319-262-0512.*

CIRCLE NO. 16 ON FREE CARD

Wireless Modem

The Sierra Wireless PocketPlus wireless modem features multiple data communications options, including 19,200-bps CDPD (Cellular Digital Packet Data) and 14,400-bps V.32bis and V.17 fax over circuit switched cellular and wired-line PSTN (Public Switched Telephone Network). It incorporates a cellular transceiver and rechargeable batteries into a palm-sized, serially-connected modem for *Windows*- and Macintosh-based portable computers. $1,195. *Sierra Wireless, Inc., #260, 13151 Vanier Pl., Richmond, British Columbia, Canada, V6V 2J2; tel.: 604-231-1100; fax: 604- 231-1109.*

CIRCLE NO. 17 ON FREE CARD

THE HARD DRIVE GOOD BOOK

HARD DRIVE BIBLE

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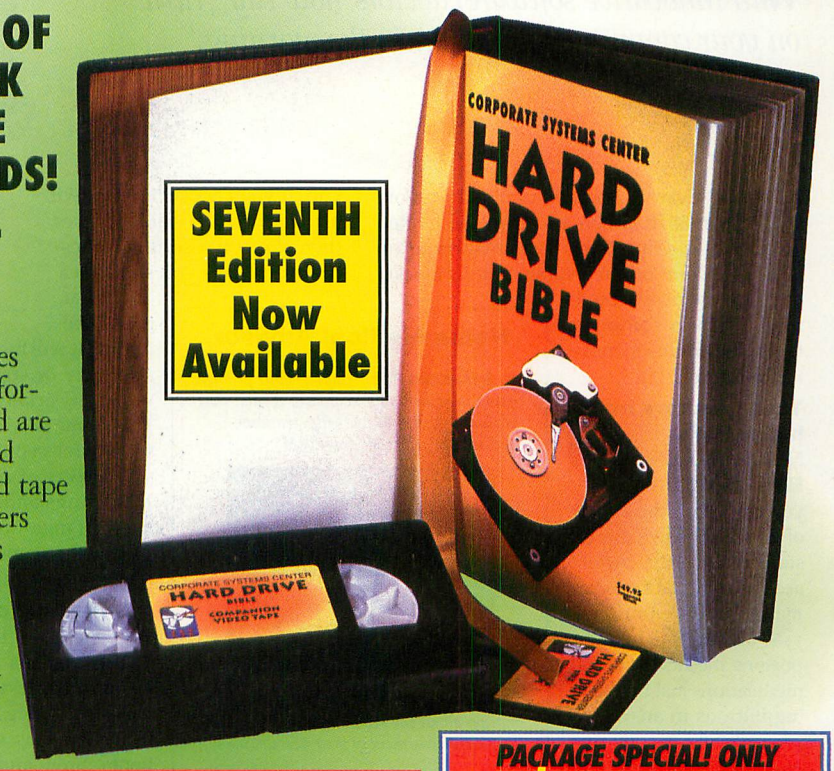
The guys who wrote the book on hard drives now bring you years of experience and technical information in our all new Hard Drive Bible. Included are installation instructions, drive parameter tables, and setup information on hundreds of hard, optical, and tape drives. Be sure to check out the new SCSI Parameters chapter, one of many new features. Jumper settings and compatibility information on controller cards and driver software have all been revised and updated. Don't miss the benchmark chapter with performance and reliability test reports. This book and software are essential for all dealers and system integrators who install hard drives.



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- Free copy of CSC's drive performance test software and low level format programs.
- Free copy of Seagate's technical support software.

Advice that can save your family thousands in medical bills...

With innovative software, doctors now say "turn on your computer and call me in the morning."

By Charles Anton

Health care costs have doubled to more than $850 billion a year in the United States. One of the best answers to reduce this drain on the average family pocket book is preventative medicine. What is computer technology doing to make this possible?

These doctors make house calls.
Now, with Dr. Schueler's Home Medical Advisor you can enjoy the power of diagnostic medicine instantly. You gain instant access to the latest information on symptom analysis, diseases, injuries, poisons, medical tests and medications just by pushing buttons in answer to prompts from this extremely thoughtful and unique program.

Send your computer to medical school.
In a very real sense you will be sending your computer to medical school. It's so simple. The computer actually interacts with you. It asks for personal medical history so that you can take a more active role in maintaining your own health. It would normally cost a fortune to obtain the advice of 40 different physicians. But with this program, which is now a best seller in its field, you'll get just that. Medical knowledge like this will no longer cost you and your family thousands in medical bills.

The "Advisor" leads you through.
The program was designed with the home user in mind. You can look up diseases, injuries, poisons, drugs, health and diet. From the 70-item symptom file, you pick the one that most closely describes what ails you. If you choose 'fever' it will list a dozen possible causes, then ask you a series of questions, and give you some idea of what could be wrong. It will then suggest a remedy or suggest you visit a physician specialist. The Home Medical Advisor also tells you about the side effects of more than 1,200 drugs and the treatment for ingestion of more than 500 common household substances.

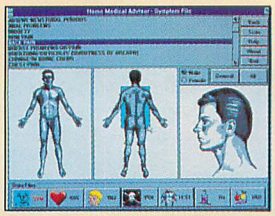
Cut medical costs.
Advisor users help their doctors make a diagnosis faster, with less tests, by communicating more effectively. This saves patients time and money. Physicians agree with the Advisor. It will help you help yourself, with important tips on diets, staying healthy, self-care, fitness, and healthy life styles.

The critic's choice.
There are other programs that contain medical information. But the critics of such software complain that they are hard to use.

Not so with the Home Medical Advisor. *Longevity Magazine* called it "The best doc-in-the-box program around... it not only deluges you with medical information but presents it in a manner that no book can duplicate." *Business Week Magazine* writes "Home Medical Advisor helps you diagnose problems and decide whether a trip to the doctor is necessary..." *Byte Magazine* concludes "Once you've consulted HMA, you'll know what to expect when you seek treatment, and you'll be better able to choose specialists."

Home Medical Advisor

- **Symptom File:** *Analyze your problem using the question and answer format that generates over 600 color illustrations, making 450 different diagnoses.*



- **Disease File:** *Access detailed information about the signs, symptoms, evaluation and treatment of over 450 diseases.*
- **Injury File:** *Explore over 130 different injuries - everything from a gunshot wound to scuba injuries.*

- **Poison File:** *Over 500 common household substances and products, and what you should do if ingestion occurs.*
- **Drug File:** *Over 800 prescription and nonprescription drug indications, side effects and drug interaction.*
- **Test File:** *Over 125 of the most frequently performed medical tests. Find out how, when and why they are done, their risks and possible complications.*
- **Referral File:** *A listing of the board certified specialists in your state could make choosing your doctor easy.*

A wealth of knowledge.
The Home Medical Advisor was created by Dr. Stephen Schueler, emergency department director at Holme Regional Medical Center, with the added expertise of 40 board-certified physician specialists. The program includes a 74-page manual with medical glossary, first aid information and easy instructions.

Easy upgrade with new information.
Periodically you can update your Home Medical Advisor with the latest medical information from diseases and nutrition to tips on staying healthy. Plus you'll receive updated listings of area specialists....for only a small fee.

Direct from the doctor to you.
A sophisticated medical software program like this can retail for $250 or more. But through this special promotional offer, this wealth of medical knowledge can be yours for only $69 for the DOS version ($79 for the Windows 3.1 version.) These prices are available for a limited time.

Risk-free money-back guarantee.
The Home Medical Advisor is backed-up by our "No Questions Asked" money-back guarantee. If you're not completely satisfied, simply return it within 30 days for a full refund.

The Home Medical Advisor is available in both 3.5 and 5.25 disk format. Please indicate your choice of DOS or the Windows version when ordering.

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HMA for windows 3.1	**$79**	$4 S&H

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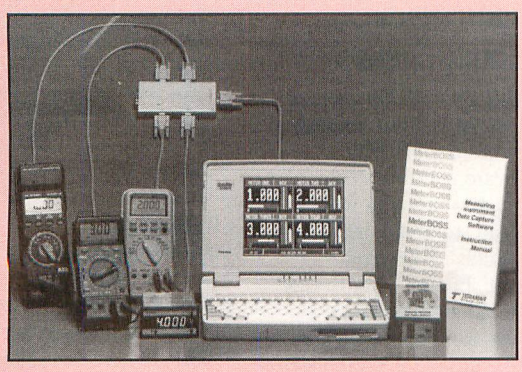


Serial-Port Expander

PortMUX from MicroMeters is an automatic serial-port expander/selector box that provides four extra serial ports for use with any PC in connecting smart meters, controllers, counters, sensors and transmitters. Intended as companion hardware for use with MeterBOSS multiple-meter software.

PortMUX has five DB-9 connectors, a cable to the PC and LED indication of ports in use. Enabling software identifies which port is connected to which device. $199. *Micro Meters, 4509 Runway St., Simi Valley, CA 93063; tel.: 805-522-0683; fax: 805- 522-1568.*

CIRCLE NO. 23 ON FREE CARD

Programmable Power Management

Power Brain is a Quantum Composers PC-based power-management system It's a programmable device for managing recurring operations, turning on and off power at preset times and performing a variety of unattended tasks. Its hardware consists of a controller, power supply, power outlet module and associated cables. Its software is a routine in either DOS or *Windows* and the program launcher and off-screen utilities. Other uses for PowerBrain are for controlling lights, instruments, appliances and printers. $175. *Quantum Composers, 210 Cirque Dr., Bozeman, Montana 59715; tel.: 800-556-9686; fax: 4066-587-8828.*

CIRCLE NO. 24 ON FREE CARD

Inkjet Printer

ExecJet IIc from Lexmark is an entry-level color inkjet printer that features a print speed of 2.5 to 7 minutes per page in quality color mode and up to three pages per minute in black draft mode. The printer has 12 resident scalable fonts, and its 150-sheet input can handle paper sizes up to 9" x 14.33", including envelopes, labels and transparency sheets. Anticipated street price is less than $350. *Lexmark International, Inc., 740 New Circle Rd. NW, Lexington, KY 40511; tel.: 800-358-5835.*

CIRCLE NO. 25 ON FREE CARD

Software

UART Expert

UART Expert from Tall Tree is a software test tool for diagnosing problems with asynchronous communications. It provides access to all parameters on the UART chip and direct visibility of all characters sent and received, including control and extended characters. $150. *Tall Tree Software, PO Box 3501, Fullerton, CA 92634; tel.: 714-773- 0301.*

CIRCLE NO. 26 ON FREE CARD

Windows Calculators

CalcPac from System Essentials is a set of four calculator

programs for Microsoft *Windows*. *CalcPac Business* operates like the BA-II Executive Business Analyst from Texas Instruments. *CalcPac Scientific* operates like the TI-36X and has over 160 functions. *CalcPac Conversions* is a straightforward conversions calculator that can perform more than 2,000 conversions from 23 categories. *CalcPac Tape Calculator* is constructed to operate like a standard desktop adding machine.

The scientific and business calculators are programmable, have tapes and can generate graphs of data sets and loan payments in multiple presentation styles. $59.95. *System Essentials, Inc., 14858 Grassmere Ct., Chesterfield, MO 63017; tel.: 314-537-9537; fax: 314-536-2905.*

CIRCLE NO. 27 ON FREE CARD

Software Reference Library

Great Bear Technology's *ReferenZing* is a *Windows*-based dictionary, thesaurus and encyclopedia that's accessible from the toolbar in such popular word-processing applications as *WordPerfect*, Microsoft *Word* and *Ami Pro*. You can search for words in six different ways: partial word, advanced search, rhymes, crosswords, anagrams and jumbles. The program is based on the *New American Library Desk Reference* set, which includes three comprehensive reference tools: *The New American Handy College Webster Dictionary*, *Roget's College Thesaurus*, and *The New American Desk Encyclopedia*. $49.95. *Great Bear Technology, Inc., 1100 Moraga Way, Ste. 200, Moraga, CA 94556; tel.: 510-631-1600; fax: 510-631-6735.*

CIRCLE NO. 28 ON FREE CARD

Graphical Loan Analysis

PC-Loan is a 20/20 Software personal finance program designed to help businesses and consumers visually understand the financial effects of different load and financing alternatives. The program runs under *Windows* and calculates the normal attributes of financing alternatives and displays payment patterns graphically. A compare feature analyzes and graphically shows which loan alternative is superior and by how much. $59.95. *20/20 Software, 8196 SW Hall Blvd., Ste. 200, Beaverton,* OR 97005; tel.: 800-735-2020; fax: 503-520-9118.

CIRCLE NO. 29 ON FREE CARD

Windows Debugger Interface

Systems and Software's *SoftProbe 386EX/SIM for Windows* is a graphically-oriented debugger for embedded 386 development. It's designed to drive simulators, in-circuit emulators, ROM-based monitors and real-time kernels. Features include: backward compatibility with existing *SoftProbe* command files; source-level and symbolic debugging for C and C++; extensive system-level and peripheral views; built-in simulation of the Intel 386EX CPU and all on-chip peripherals; simulation of additional peripherals for PC-compatible system designs; and extensive facilities for user-defined peripheral models, triggers and unlimited trace including information about instruction execution, register changes, and bus-level activity. *Systems and Software, Inc., 18102 Cowan, Ste. 100, Irvine, CA 92714; tel.: 714-833-1700; fax: 714-833-1900.*

CIRCLE NO. 30 ON FREE CARD

Digital Funhouse

Symsoft's *Digital Funhouse for Windows* is a photo-manipulation software tool that quickly creates special photographic effects. It accepts images from a wide variety of sources, such as scanners, digital cameras, CD-ROMs, bulletin board systems, photo clipart and others. It supports all major desktop-publishing, word-processing, and multimedia programs, *Windows* file formats and the TWAIN scanner interface.

Digital Funhouse features include: 30 visual effects, such as swirl, bulge, kaleidoscope, pencil drawing, oil painting, etc.; basic digital photoshop capabilities, such as scanning, tone adjustment, color correction, sharpen and blur; 24-bit color and 256-level grayscale printing and faxing; ability to alter full or partial images. $79.95. *Symsoft Corp., PO Box 10005, Incline Village at Lake Tahoe, Lake Tahoe, NV 89450; tel.: 702-832-4300; fax: 702-832-4310.*

CIRCLE NO. 31 ON FREE CARD

Cloaking Upgrade

Cloaking Version 2.0 from Helix Software is a tool kit for software developers to create drivers and memory-resident programs that use the Helix Cloaking device driver and run entirely in extended memory in 32-bit protected mode. This new version offers developers several new features, including: bridging of the development of TSRs and device drivers between DOS/*Windows* and *Windows 95* environments; a memory manager is no longer required when using Cloaking technology; and enhanced development services. Additionally, 286 computers are supported for the low-end installed base. $299. *Helix Software, 4709 30 St., Long Island City, NY 11101; tel.: 718-392-3100; fax: 718- 392-4212.*

CIRCLE NO. 32 ON FREE CARD

PhoneDisc Upgrade

Digital Directory Assistance's *PhoneDisc* telephone directory listings on CD-ROM provides instant access to more than 91 million people, businesses and organizations. This latest version removes the limit on the number of business listings that can be exported and mailed using *PhoneDisc*. This offers users greater access to almost 10-million up-to-date and accurate business directory listings. $129. *Digital Directory Assistance, 6931 Arlington Rd., Ste. 405, Bethesda, MD 20814; tel.: 800-284-8353; (617) 639-2980.*

CIRCLE NO. 33 ON FREE CARD

VirusScan Upgrade

McAffee's *VirusScan* 2.1 antivirus software for network workstations and standalone desktops maintains *VirusScan*'s detection rates, while significantly improving speed, ease-of-use, management flex-

(Continued on page 108)

Multimedia Family Trees

Family Tree Maker Deluxe CD-ROM Edition Version 2.0 from Banner Blue Software features an electronic scrapbook in which you can store and organize thousands of scanned images, photos from Kodak Photo CDs and such OLE objects as home video and audio clips. The Scrapbook can store up to 16,000 images per person, each item with its own caption, date and description. Basic editing of images, such as cropping and rotating, is also available.

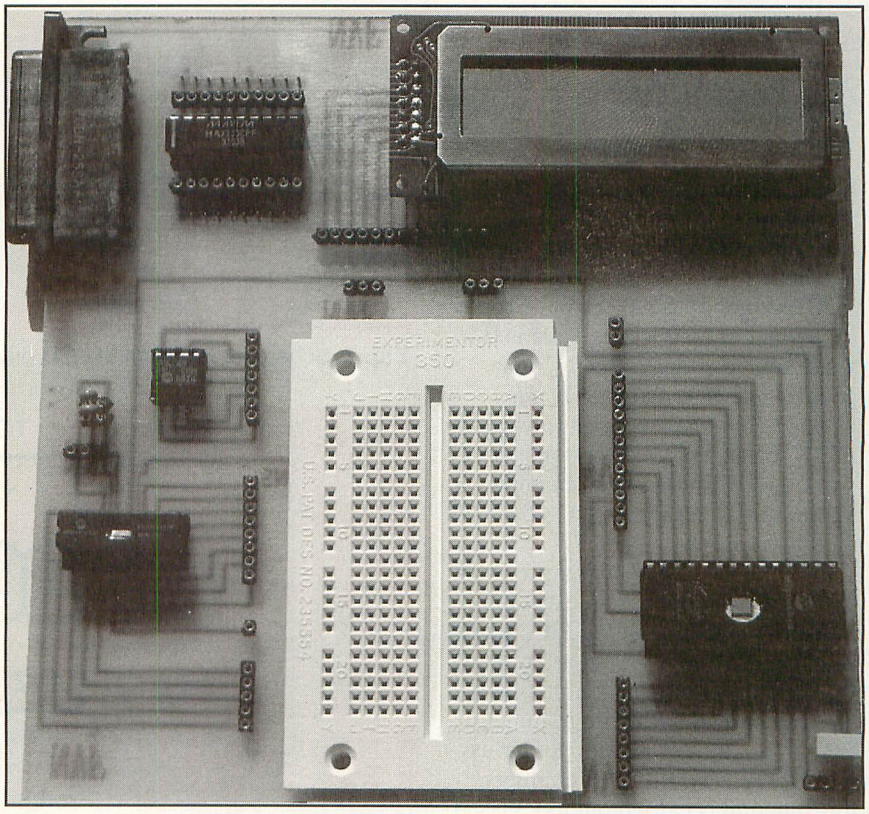
The new version also includes 320M of archival information on-line. A FamilyFinder feature lists the names of 100-million deceased persons who appear in state and federal records and tells you where you can find information about each listed person. $60. *Banner Blue Software, PO Box 7865, Fremont, CA 94537; tel.: 510794-6850; fax: 510-794-9152.*

CIRCLE NO. 34 ON FREE CARD

By Fred Eady

Build a PIC16Cxx Breadboarding System

Lets you prototype and experiment with PIC-based circuits



So far in this series on PICs, I've covered basic theory, including hardware descriptions and implementation data on the 12-bit PIC16C5X family, 14-bit PIC16C71 and EEPROM-based PIC16C84. Tally in two super-low-cost PIC programmer kits, one for the PIC16C5X parts identified as the PIC16C54/55/ 56/57 at $69.95 and another designed for the 14-bit PIC16CXX family identified as the PIC16C64/74/71/84 at $49.95. The circuitry and software featured in the May/June issue supplied working real-world PIC coding examples, while I provided in the March/April issue a basic data logger application for the analog-to-digital-converter-equipped PIC16C71. Last time, I covered the Intel HEX file layout and provided serial communication theory and a hobby servo application for the EEPROM-based PIC16C84.

This time out, I describe a low-cost, highly functional PIC16CXX breadboard I called the PIC-PERF, which you can build. With it, you can prototype and experiment with the PIC16C54/55/56/57, PIC16C71 and PIC16C84. The breadboard has accommodations for an HD44780-controller-based LCD display, DL-1414 alphanumeric LED module, user-defined serial/parallel interface, 512-byte Microchip 93LC66 serial EEPROM and a readily available 2" X 3" experimenter socket. Fleshing things out are some code snippets, theory and schematics to help you get started on your own PIC projects.

Source Code

In this project, the idea is to interconnect wires between the desired components and effect a working PIC-based electronic module or electrical circuit of your own design. The major difference here is that some of the components on the PIC-PERF breadboard are "smart." Therefore, let's look at how you can "enlighten" the PICs and other intelligent devices found on the PIC-PERF.

In my experience, the most-important tool for programming PICs is a good ASCII text editor. Most bells and whistles aren't necessary, but be sure the editor you use can at least search and replace characters and copy and move text blocks and characters within the source text.

I find that most of my "programming" involves moving and changing the text in source files. The editor with which you work should be able to produce an ASCII file without resorting to use of special ASCII codes and characters that may be misinterpreted by the assembler.

The editors included in off-the-shelf DOS are examples of good basic source-code editors and, in fact, can be used to do just this. At ED Technical Publications, I use Borland's BRIEF because it's rich in features,

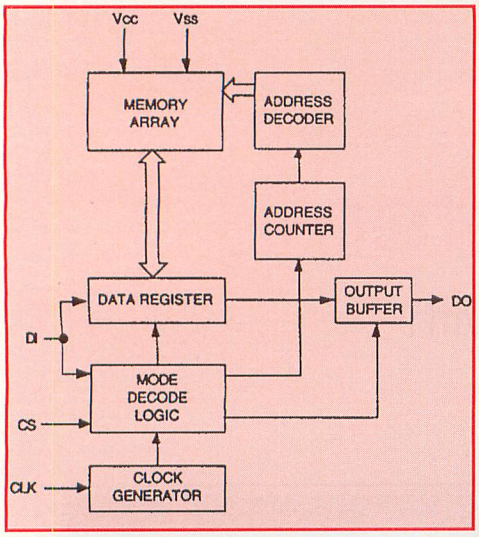


Fig. 1. Block diagram of Microchip 93CLxx series CMOS serial EPROM. (Courtesy Microchip Technology Inc.)

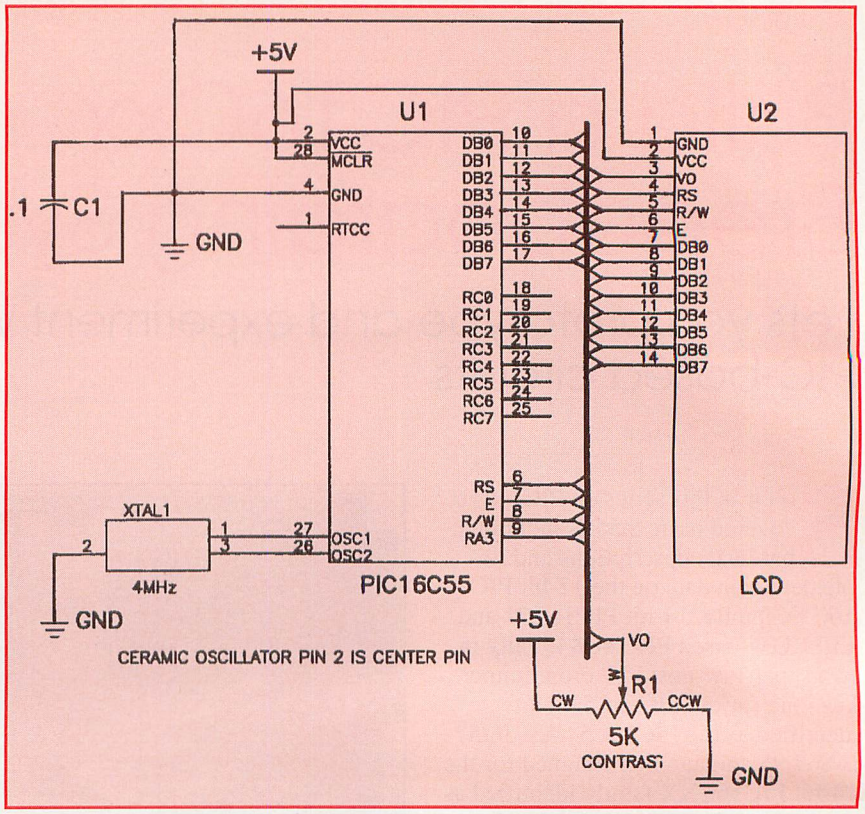


Fig. 2. Schematic diagram of LCD driver using PIC16C55 microcontroller.

highly functional and easy to use. It allows me to assemble PIC source code modules without leaving the editor shell.

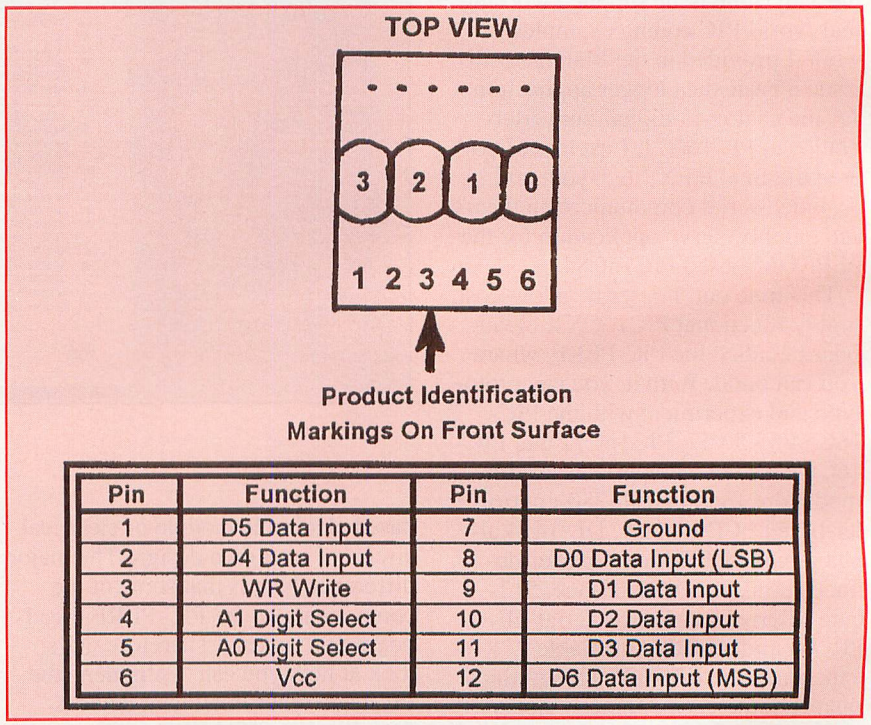
A very good way to learn the ropes of laying out your source code is to study source code written by other people. The *Microchip Embedded Control Handbook* contains a wealth of PIC code. There are also plenty of working PIC source-code examples on the EDTP BBS (tel.: 407-454-3198 24 hours a day).

Once you've written your program, assemble it to produce an executable module. In the case of the PIC, the executable module is output as an Intel HEX file that's translated into binary equivalent by the PIC programmer or PIC programmer software you're using. With EDTP PIC programmers, this function is carried out in C-based software running on the PC. This results in the PIC programmer being presented with a binary representation of the assembled code.

Most problems you encounter when assembling source code will result from a misunderstanding of exactly how to enter the assembly command. The following is a valid command-line sequence for the Microchip MPASM assembler and can be used to assemble a source-code file for the PIC16C54:

```
MPASM /aINHX8M /PIC16C54
filename.xxx
```

This command simply invokes the Microchip assembler in eight-bit Intel HEX format (/aINHX8M) for the PIC-16C54 (/PIC16C54) using "filename-.xxx" as the input source-code file. If all goes well, you end up with a file called "FILENAME.HEX," which is technically termed an object module and is the file you want to send to the programmer and, ultimately, into your target PIC.



Pin	Function	Pin	Function
1	D5 Data Input	7	Ground
2	D4 Data Input	8	D0 Data Input (LSB)
3	WR Write	9	D1 Data Input
4	A1 Digit Select	10	D2 Data Input
5	A0 Digit Select	11	D3 Data Input
6	Vcc	12	D6 Data Input (MSB)

Fig. 3. Pinout details for litronix DL-1414 alphanumeric intelligent display chip. (Courtesy litronix)

Listing 1. EEPROM Example Code For 93LC66.

```
;E D TECHNICAL PUBLICATIONS 1993-1994
;
;93LC66 EEPROM EXAMPLE CODE
;
;PIC16C54 BASED
;
;MICROCOMPUTER JOURNAL

;********** INCLUDE STATEMENT FOR PREDEFINED EQUATES
;
 INCLUDE "PICREG.EQU"

;********** PORT B EEPROM BIT EQUATES
;
DO      EQU  0H
DI      EQU  1H
ICLK    EQU  2H
CS1     EQU  3H

;********** PIC16C54 REGISTER EQUATES
;

EEPROM    EQU  6H

;*********************** Data RAM Assignments **********************
;
;
READCMD         EQU             08H
WRITECMD        EQU             09H

SCRATCH1        EQU             0AH
SCRATCH2        EQU             0BH

ADDRESS         EQU             0CH
_DATA           EQU             0DH

;*****************************************************************
;
;  EEPROM COMMAND BYTE AND ADDRESS REGISTER LAYOUT
;
;
;BIT            |7          |6          |5          |4          |3          |2          |1          |0
;               |           |           |           |           |           |           |           |
;               |           |           |           |           |           |           |           |
;               |MSB        |           |           |LSB        |MSB        |           |           |
;COMMAND        |OPCODE     |OPCODE     |OPCODE     |OPCODE     |ADDRESS    |           |           |
;               |           |           ||          |           |           |           |           |
;_____________________________________________________________________________________________________
;
;               |           |           |           |           |           |           |           |
;               |           |           |           |           |           |           |           |
;ADDRESS        |A7         |A6         |A5         |A4         |A3         |A2         |A1         |A0
;
;
;*****************************************************************

;********** MAIN CODE
;

        ORG     0
BEGIN
;********** SETUP PORTS A AND B

    MOVLW       B'00000001'             ;SET UP I/O FOR PORT B
    TRIS        Port_B                  ;DO IT
    BCF         EEPROM,CS1              ;MAKE SURE CHIP SELECT IS LOW

    BCF         EEPROM,ICLK             ;MAKE SURE EEPROM CLOCK LINE IS LOW
    BCF         EEPROM,DI               ;MAKE SURE EEPROM DI LINE IS LOW

    MOVLW       B'10000000'             ;INITIALIZE THE READ COMMAND REG
    MOVWF       READCMD

    MOVLW       B'01000000'             ;INIT WRITE COMMAND REG
    MOVWF       WRITECMD

    MOVLW       0
    MOVWF       ADDRESS                 ;SET ADDRESS TO 0


;********** WRITE DATA TO 93LC66 EEPROM
;
```

Now it's time to load the program into the PIC's EPROM or EEPROM if you're targeting the PIC16C84. If you're lost at this point, simply type in PICPROG and press Enter if you're using the EDTP PIC16C5X programmer, and you'll see:

```
PIC16C5X PROGRAMMER VERSION X.X
E D TECHNICAL PUBLICATIONS
```

on your PC's video screen. You entered the following parameters:

```
PICPROG
```

Correct command syntax is:

```
PICPROG B(lank Check) <PIC> <COM
PORT>
PICPROG R(ead) <filename.obj> <PIC>
<COM PORT>
PICPROG V(erify) <filename.obj> <PIC>
<COM PORT>
PICPROG P(rogram) <filename.obj>
<PIC> <COM PORT> <oscillator> <W/D>
<P/U>
PICPROG P(rogram) <filename.obj>
<PIC> <COM PORT> (FUSE OPTIONS IN
FILE)
```

For example, PICPROG P SAMPLE.OBJ 54 1 RC D U loads and programs the file SAMPLE.OBJ into a PIC16C54 using an RC oscillator with watchdog timer and Code Protect disabled using COM1. Valid oscillator types are LF, RC, XT and HS; valid PIC types are (16C)54, (16C)55, (16C)56 and (16C)57, and valid ports are COM1 and COM2.

Notice that "FILENAME.OBJ" is "FILENAME.HEX" in your assembler command-line example and that the correct syntax to invoke the PICPROG functions is:

```
PICPROG P FILENAME.HEX 54 1 RC D U
```

This command line invokes the PC program PICPROG and requests a program operation using "FILENAME .HEX" as the input object file for a PIC16C54. The EDTP PIC programmer is attached to COM1, and the target PIC will be programmed to use the RC oscillator option with watchdog timer and code protection disabled.

If you're using the PIC16CXX programmer, which programs the 14-bit devices, the screens you obtain are similar, but you invoke the program

```
    MOVLW   55H             ;WRITE A 55 TO ADDRESS 0
    MOVWF   _DATA

    CALL    EWEN            ;ENABLE EEPROM FOR WRITE

    BSF     EEPROM,CS1      ;SELECT EEPROM
    BSF     EEPROM,DI       ;START BIT
    NOP                     ;KILL SOME TIME

    BSF     EEPROM,ICLK     ;PRODUCE A CLOCK PULSE
    NOP
    BCF     EEPROM,ICLK     ;CLOCK OUT START BIT

    MOVLW   2H              ;LOAD SCRATCH REGISTER WITH 2 DECIMAL
    MOVWF   SCRATCH1        ;OPCODE IS 2 BITS LONG

    MOVF    WRITECMD,W
    MOVWF   SCRATCH2        ;LOAD SCRATCH2 WITH WRITE COMMAND
BYTE

;********** TRANSMIT WRITE OPCODE TO EEPROM (01)
;
COMMAND_OUT
    BCF     EEPROM,DI       ;ASSUME FIRST BIT MAY BE 0
    RLF     SCRATCH2,Same   ;ROTATE MSB DATA BIT INTO CARRY
    BTFSC   STATUS,C        ;CHECK CARRY
    BSF     EEPROM,DI       ;IF DATA BIT IS 1, SET DI
    NOP                     ;KILL SOME TIME

    BSF     EEPROM,ICLK     ;CLOCK BIT OUT TO EEPROM
    NOP
    BCF     EEPROM,ICLK

    DECFSZ  SCRATCH1,Same   ;DECREMENT BIT COUNTER
    GOTO    COMMAND_OUT     ;GO SEND NEXT COMMAND BIT

    RLF     SCRATCH2,Same
    RLF     SCRATCH2,Same   ;ROTATE PAST 2 UNUSED OPCODE BITS

;********** TRANSMIT MSB ADDRESS BIT TO EEPROM
;
    BCF     EEPROM,DI       ;ASSUME FIRST BIT IS 0
    RLF     SCRATCH2,Same   ;ROTATE MSB ADDRESS BIT INTO CARRY
    BTFSC   STATUS,C        ;CHECK CARRY

    BSF     EEPROM,DI       ;SET DI BIT IS CARRY IS SET
    NOP

    BSF     EEPROM,ICLK     ;PULSE THE EEPROM CLOCK LINE
    NOP
    BCF     EEPROM,ICLK

    MOVLW   8H              ;SEND 8 BITS OUT..ADDRESS 0-7
    MOVWF   SCRATCH1        ;LOAD SCRATCH1 WITH COUNT OF 8

    MOVF    ADDRESS,W       ;LOAD ADDRESS VALUE INTO W
    MOVWF   SCRATCH2        ;LOAD SCRATCH2 WITH ADDRESS VALUE

;********** TRANSMIT REMAINING ADDRESS BITS TO EEPROM (8 BITS)
;
ADDRESS_OUT
    BCF     EEPROM,DI       ;ASSUME FIRST BIT MAY BE 0
    RLF     SCRATCH2,Same   ;ROTATE MSB DATA BIT INTO CARRY
    BTFSC   STATUS,C        ;CHECK CARRY

    BSF     EEPROM,DI       ;IF DATA BIT IS 1, SET DI
    NOP

    BSF     EEPROM,ICLK     ;PULSE EEPROM CLOCK LINE
    NOP
    BCF     EEPROM,ICLK

    DECFSZ  SCRATCH1,Same   ;DECREMENT THE ADDRESS BIT COUNT
    GOTO    ADDRESS_OUT     ;GO SEND NEXT ADDRESS BIT

;********** TRANSMIT DATA TO EEPROM (8 BITS)
;
    MOVLW   8H              ;SEND 8 BITS OUT..DATA 0-7
    MOVWF   SCRATCH1        ;LOAD SCRATCH1 WITH 8

DATA_OUT
    BCF     EEPROM,DI       ;ASSUME FIRST BIT MAY BE 0
```

```
        RLF     _DATA,Same      ;ROTATE MSB DATA BIT INTO CARRY
        BTFSC   STATUS,C        ;CHECK CARRY

        BSF     EEPROM,DI       ;IF DATA BIT IS 1, SET DI
        NOP

        BSF     EEPROM,ICLK     ;PULSE EEPROM CLOCK LINE
        NOP
        BCF     EEPROM,ICLK

        DECFSZ  SCRATCH1,Same   ;DECREMENT THE DATA BIT COUNT
        GOTO    DATA_OUT

        BCF     EEPROM,CS1      ;DESELECT EEPROM
        BCF     EEPROM,DI       ;MAKE SURE DI IS LOW GOING OUT

        BSF     EEPROM,CS1      ;SELECT EEPROM
BUSYHI
        BTFSC   EEPROM,DO       ;STAY HERE WHILE DO IS HIGH
        GOTO    BUSYHI

REALBUSY
        BTFSS   EEPROM,DO       ;REAL BUSY OCCURS HERE
        GOTO    REALBUSY

        BCF     EEPROM,CS1      ;DESELECT EEPROM

        CALL    EWDS            ;DISABLE EEPROM WRITE

        GOTO    $               ;LOOP HERE FOREVER

;********** END OF EXAMPLE CODE
;


;********** 93LC66 EEPROM ERASE/WRITE DISABLE SUBROUTINE

EWDS
        MOVLW   B'10000000'     ;START BIT PLUS WRITE DISABLE COMMAND
        MOVWF   SCRATCH2        ;SAVE COMMAND TO SCRATCH MEMORY
        GOTO    EW              ;BYPASS WRITE ENABLE SETUP

;********** 93LC66 EEPROM ERASE/WRITE ENABLE SUBROUTINE

EWEN
        MOVLW   B'10011000'     ;START BIT PLUS WRITE ENABLE COMMAND
        MOVWF   SCRATCH2        ;SAVE COMMAND IN SCRATCH MEMORY

EW

        MOVLW   0CH             ;LOAD SCRATCH REGISTER WITH 12 DECIMAL
        MOVWF   SCRATCH1        ;WRITE ENABLE COMMAND IS 12 BITS LONG

        BCF     EEPROM,ICLK
        BCF     EEPROM,DI       ;MAKE SURE DI IS LOW...NO START BIT
        BCF     EEPROM,CS1      ;MAKE SURE EEPROM IS DESELECTED

        BSF     EEPROM,CS1      ;SELECT EEPROM
EWOUT
        BCF     EEPROM,DI       ;ASSUME FIRST BIT IS 0
        RLF     SCRATCH2,Same   ;ROTATE MSB INTO CARRY
        BTFSC   STATUS,C        ;CHECK CARRY

        BSF     EEPROM,DI       ;SET DI IS CARRY IS SET
        NOP

        BSF     EEPROM,ICLK     ;PULSE THE EEPROM CLOCK
        NOP
        BCF     EEPROM,ICLK

        DECFSZ SCRATCH1,Same    ;DECREMENT THE COMMAND BIT COUNT

        GOTO    EWOUT           ;GO SEND NEXT COMMAND BIT

        BCF     EEPROM,CS1      ;DESELECT EEPROM
        BCF     EEPROM,DI       ;MAKE SURE DI IS LOW GOING OUT

        RETLW   0               ;RETURN FROM SUBROUTINE


        DATA    "08-09-94"

        DATA    "93LC66 EXAMPLE"

        ORG     PIC54
        GOTO    BEGIN           ;PIC16C54 RESET VECTOR
        END
```

using PICXX, where "XX" is 71, 64 or 84, depending upon the PIC type you're programming. The user interface for each of the 12- and 14-bit PIC terminal programs is identical.

I suggest that you look over the extensive documentation file that comes with the Microchip assembler for more details on additional MPASM functions. Also, download the PIC-16C5X and PIC16CXX programmer text files and source code from the E D Technical Publications BBS for further study.

To access Microchip's BBS follow these steps:

(1) Set your modem to 7E1 and dial 800-848-8980.

(2) Follow the directions on your video monitor's screen to locate a CompuServe telephone number closest to you.

(3) Once you have the CompuServe number, set your modem to 8N1 and dial the local CompuServe number.

(4) Pressing the Enter key causes garbage to appear on your monitor's screen.

(5) Hit + and press Enter. Host Name: should appear.

(6) Type MCHPBBS and press Enter to connect to the Microchip BBS.

The Hardware

As far as hardware is concerned, simply interconnect the components on the PIC-PERF breadboard using machined-pin and experimenter-block interfaces and 22-gauge or smaller insulated solid hookup wire to obtain the desired results. Each pin for every active component is brought out to a row of female machined-pin headers and identified to aid in faster prototyping of PIC circuits.

The machined pins I used in the engineering prototype were Digi-Key Part No. 208 that tightly accommodate 22-gauge wire. The pins you use may require a different gauge of wire. Note that either ceramic oscillators or crystals, the latter with accompanying capacitors, can be used to clock either PIC. If you're using a ceramic oscillator, be sure to omit the capacitors. When using a crystal, mount a set of 27-pF capacitors.

• **93LC66 CMOS Serial EEPROM.** This Microchip device is a 4K-bit low-voltage serial EEPROM. Instructions, addresses and write-data are clocked

into the DI pin on the rising edge of the clock, which is normally supplied by a firmware routine running on one of the PIC devices housed on the PIC-PERF breadboard.

The serial clock is used to synchronize communication between the PIC and the 93LC66. Opcode, address and data bits are clocked in and out on the positive edge of CLK. DI (Data In) and DO (Data Out) pass data to and from the PIC. DO is also used to provide an erase- or write-complete indication to the requesting PIC.

The 93LC66 requires no fancy timing cycles for reading and writing because it incorporates built-in timers for performing erase and write operations. The device is nonvolatile and provides instructions to disable and enable write operations. Data is automatically protected when power supplied falls less than 1.4 volts dc. A million erase/write cycles can be expected before data integrity is compromised, and static data retention is rated at in excess of 40 years.

The 93LC66 reverts to standby mode until selected. Selection occurs when CS is brought high. In our instance, the PIC is responsible for selecting the EEPROM and does so by controlling the CS line. Standby mode consumes about 5 amperes, while active mode needs about 1 mA of current. A block diagram of the 93LC66 is shown in Fig. 1.

The 93LC66 EEPROM Example Code given in Listing 1 details the steps necessary to write data into the 93LC66. Follow the code as I describe the EEPROM write algorithm.

A hidden feature of PIC assembler code is that, when properly commented, you can relate the equates to actual pins on the PIC device. For instance, under the heading "Port B EEPROM Bit Equates" you'll find four definitions, or equates, assigned to four bits of PIC16C54 I/O Port B. Two examples are Bit 0, designated DO, and Bit 3, assigned to CS1. This can also be read as Bit 0, or pin 6 or RB0 is equivalent to DO (Data Out). The same can be said for Bit 1, or pin 7 or RB1 as DI (Data In). For this example, you can simply read the code and actually build up the meat of the EEPROM circuitry without having to reference a schematic!

You also know that the four EEPROM connections emanate from

Listing 2. Read EEPROM Data Code Snippet for 93LC66.

```
;E D TECHNICAL PUBLICATIONS 1993-1994
;
;READ 93LC66 EEPROM DATA CODE SNIPPET
;
;PIC16C54 BASED
;
;MICROCOMPUTER JOURNAL

READ_DATA

        MOVLW   8H              ;8 BITS IN..DATA 0-7
        MOVWF   SCRATCH1        ;LOAD SCRATCH1 WITH 8

DATA_IN
        BCF     STATUS,C        ;CLEAR CARRY

        BSF     EEPROM,ICLK     ;START EEPROM CLOCK PULSE
        NOP                     ;KILL SOME TIME
        BTFSC   EEPROM,DO       ;GET DATA BIT FROM DO
        BSF     STATUS,C        ;IF DO = 1..SET CARRY
        RLF     _DATAIN,Same    ;ROTATE CARRY BIT INTO HOLDING REGISTER
        BCF     EEPROM,ICLK     ;END EEPROM CLOCK PULSE

        DECFSZ  SCRATCH1,Same   ;DECREMENT THE DATA BIT COUNTER
        GOTO    DATA_IN         ;GO GET NEXT DATA BIT
```

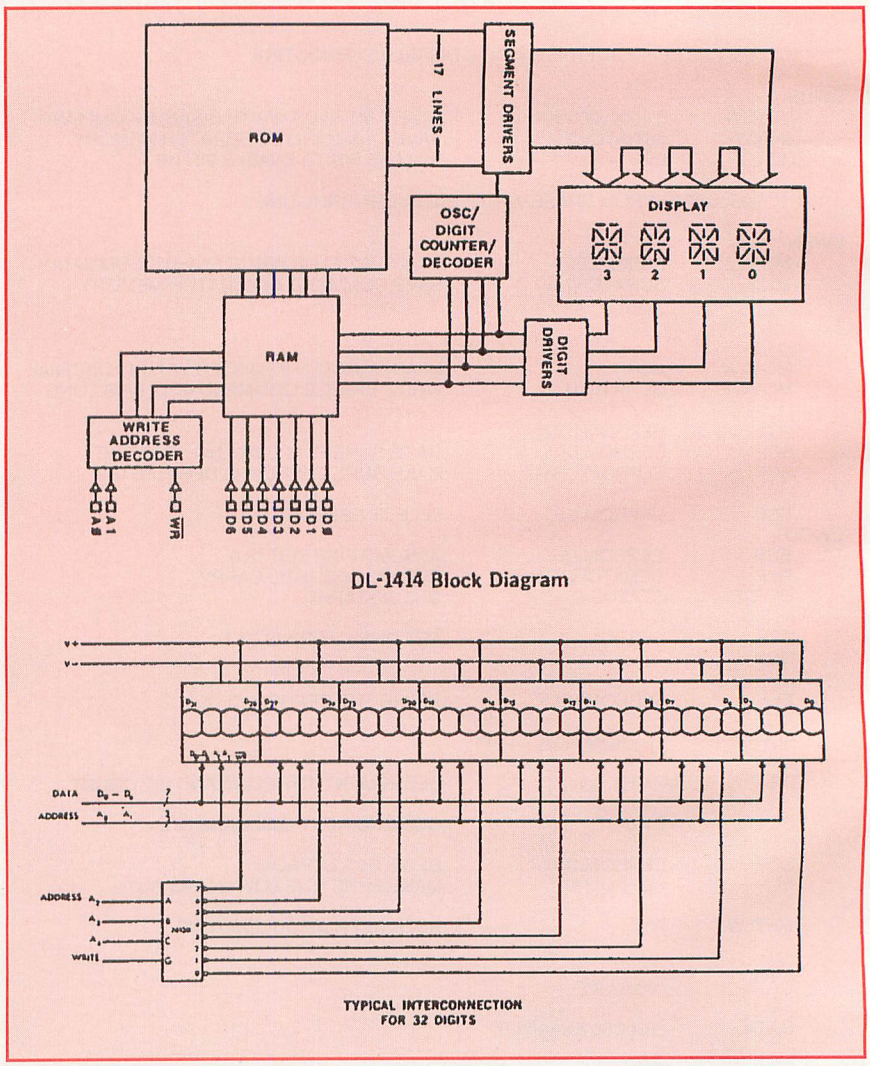


Fig. 4. Block diagram (upper) and typical interconnections for 32 digits (lower) for DL-1414. **(Courtesy Iitronix)**

Table 1. LCD Command Set for HD44780 Chip

Instruction	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Execution Time*
Clear Display	0	0	0	0	0	0	0	0	0	1	82µs~1.64ms/120µs~4.9 ms
Return Home	0	0	0	0	0	0	0	0	1		40µs~1.6ms/120µs~4.8ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	40µs/120µs
Display On/Off Control	0	0	0	0	0	1	D	C	B		40µs/120µs
Cursor & Display Shift	0	0	0	0	1	S/C	R/L				40µs/120µs
Function Set	0	0	0	0	1	DL	N	F			40µs/120µs
Set CG RAM Address	0	0	0	1	ACG						40µs/120µs
Set DD RAM Address	0	0	1	ADD							40µs/120µs
Read Busy Flag & Address	0	1	BF	AC							1µs/1µs
Write Data to CG or DD RAM	1	0	Write Data								40µs/120µs
Read Data to CG or DD RAM	1	1	Read Data								40µs/120µs

I/D = 1: Increment (+1) I/D = O: Decrement (-1)
S = 1: Accompanies Display Shift
S/C = 1: Display Shift S/C = 0: Cursor Move
R/L = 1: Shifts to Right
R/L = 0: Shifts to Left
DL = 1: Eight Bits DL = 0: Four Bits
N = 1: Two Lines N = 0: One Line
F = 1: 5 X 10 Dots F = 0: 5 X 7 Dots
BF = 1: Internally Operating
BF = 0: Can Accept Instruction

Execution changes when frequency changes.

Example:

When f_{osc} is 270 kHz:

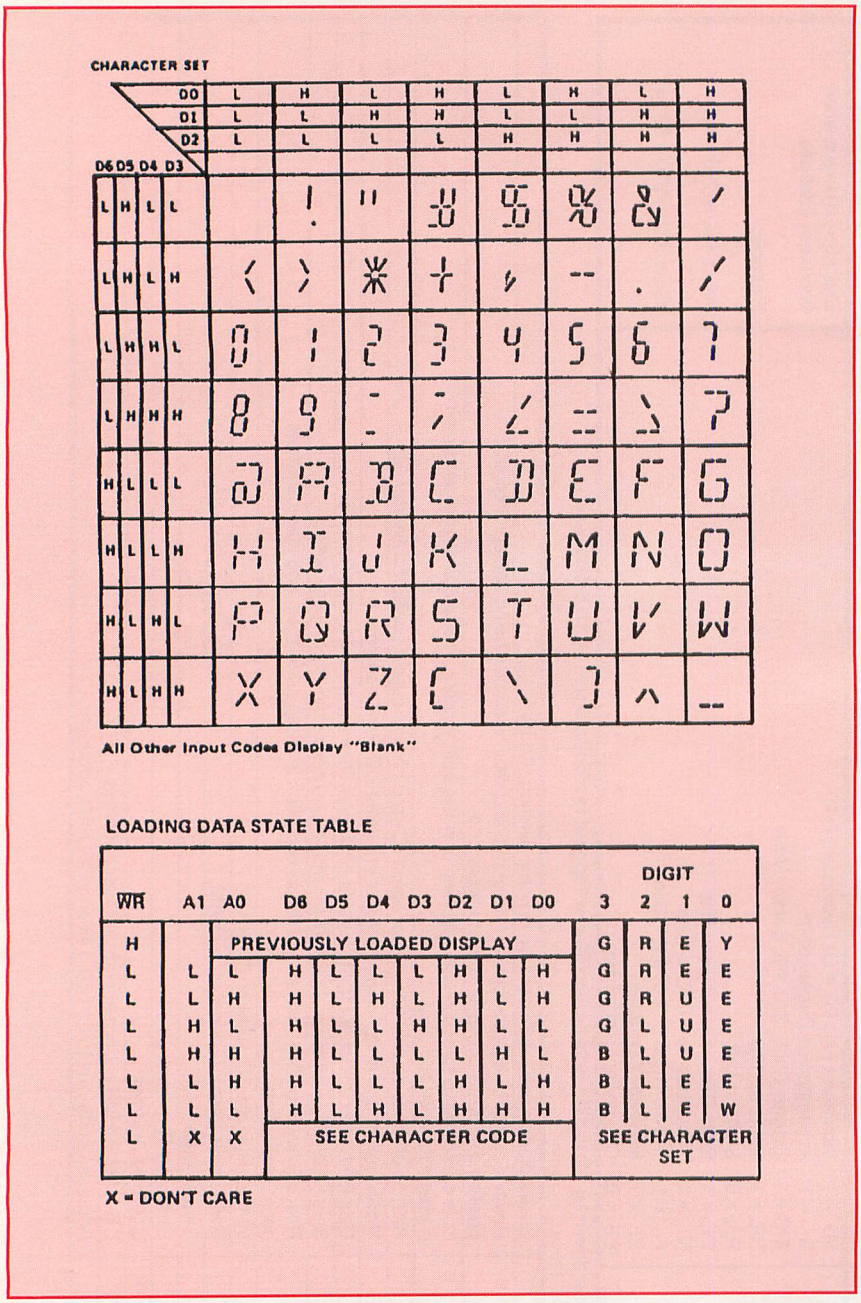
40 µs X 250/270 = 37 µs

* f_{osc} = 250 kHz (applied to models driven by 1/8 or 1/11 duty cycle)/160 kHz (applied to models driven by 1/16 duty cycle).

Clear Display	Clears display and returns cursor to home position (Address 0).
Return Home	Returns cursor to home position (Address 0) and returns display being shifted to original position. DD RAM contents remain unchanged.
Entry Mode Set	Sets cursor-move direction and specifies or not to shift display. These operations performed during data write and read.
Display On/Off Control	Sets on/off of all display (D), cursor on/off (C) and blink of cursor position character (B).
Cursor & Display Shift	Moves cursor and shifts display without changing DD RAM contents.
Set CG RAM Address	Sets interface data length (DL), number of display lines (L) and character font (F).
Set DD RAM Address	Sets CGM RAM address. CGM RAM data is sent and received after this setting.
Read Busy Flag & Address	Reads Busy flag (BF), indicating internal operation is being performed, and reads address counter contents.
Write Data to CG or DD RAM	Writes data into CG RAM or DD RAM.
Read Data to CG or DD RAM	Reads data from CG RAM or DD RAM.
DD RAM	Display Data RAM.
CG RAM	Character Generator RAM.
ACG	CG RAM Address.
ADD	DD RAM Address. Corresponds to cursor address.
AC	Address counter used for both DD and CG RAM addresses.

Port B by looking under "PIC16C54 Register Equates," where you find that EEPROM is equated to Register 6, which happens to be PIC16C54 I/O Port B. If you read the 93LC66 data sheet, you'll find that the ORG pin determines if the EEPROM is in 16- or eight-bit mode. Since we defined a ninth bit for the address (512 data locations), this logically puts the EEPROM in eight-bit mode in that the 16-bit mode can support only eight address bits, or 256 16-bit words.

At the label "BEGIN," you do the usual bit of housekeeping and initialization. Note the setup of the READCMD and WRITECMD registers. Looking back at the equates section,



CHARACTER SET

D6 D5 D4 D3	D0 D1 D2 = L L L	H L L	L H L	H H L	L L H	H L H	L H H	H H H
L H L L		!	"	$	%	&	'	
L H L H	(	)	*	+	,	-	.	/
L H H L	0	1	2	3	4	5	6	7
L H H H	8	9	:	;	<	=	>	?
H L L L	@	A	B	C	D	E	F	G
H L L H	H	I	J	K	L	M	N	O
H L H L	P	Q	R	S	T	U	V	W
H L H H	X	Y	Z	[	\	]	^	_

All Other Input Codes Display "Blank"

LOADING DATA STATE TABLE

WR	A1	A0	D6	D5	D4	D3	D2	D1	D0	DIGIT 3	2	1	0
H		PREVIOUSLY LOADED DISPLAY								G	R	E	Y
L	L	L	H	L	L	L	H	L	H	G	R	E	E
L	L	H	H	L	H	L	H	L	H	G	R	U	E
L	H	L	H	L	L	H	H	L	L	G	L	U	E
L	H	H	H	L	L	L	L	H	L	B	L	U	E
L	L	H	H	L	L	L	H	L	H	B	L	E	E
L	L	L	H	L	H	L	H	H	H	B	L	E	W
L	X	X	SEE CHARACTER CODE							SEE CHARACTER SET			

X = DON'T CARE

Fig. 5. Character set (upper) and loading data state table (lower) for DL-1414. (Courtesy litronix)

"EEPROM COMMAND BYTE AND ADDRESS REGISTER LAYOUT" defines the bit positions of the command opcode. The address register layout is also specified there. Notice, too, that since the address is nine bits in length, the most-significant address bit (MSB ADDRESS) is contained in the command register. A READ command opcode is 10, and a WRITE opcode is 01. These two bits reside in Bit locations 7 and 6, respectively, within the command register. Opcode Bits 4 and 5 aren't used in this application.

Our example will write 55h to address 0. The basic structure of writing to the 93LC66 is: (1) initiate a START condition and (2) clock an instruction into the EEPROM

A START condition occurs when CS and DI are both high with respect to the positive edge of CLK for the first time. Since the EEPROM is selected and DI is set, a START bit is presented to the EEPROM when CLK is initially taken low to high.

Following a successful START condition, the correct amount of address and data bits must follow before the clocked-in instruction can be executed. For instance, a READ instruction consists of a START bit (one bit), an OPCODE (two bits) and an ADDRESS (nine bits). The READ instruction results in eight data bits from DO. Adding up the bits, you come up with 20 bits of information and, thus, 20 cycles to complete the READ operation.

Now that you have the picture, continue to trace through the example code until the WRITE operation is finished. It's helpful to have the 93LC66 data sheet handy for answering questions related to the 93LC66 if you aren't familiar with the device's pinouts and instruction set. Since the 93LC66's READ task is very similar to its WRITE task, I've included only the read snippet of the READ code in Listing 2 instead of duplicating most of the code common to both the READ and WRITE programs.

• **LCD Display Using the HD44780.** The LCD display/HD44780 LSI IC combination comprises a dot-matrix controller/driver system that displays alphanumeric characters and symbols. The dot-matrix liquid-crystal display can be driven by almost any eight- or four-bit microcontroller. All functions required for dot-matrix liquid-crystal display drive are internally provided on a single chip located on the rear of the LCD display module's printed-circuit board. A representative PIC-to-LCD interface circuit is shown in Fig. 2.

Like the 93LC66, the HD44780 LSI IC has its own set of instructions that permit display and movement of characters on the LCD screen. To facilitate your use of this component, the code for the LCD display driver application is included in Listing 3, along with the HD44780 LCD command set in Table 1.

• **DL-1414 Intelligent Alphanumeric Display.** This four-digit display contains 16 bar segments per digit plus a decimal segment and a built-in CMOS IC. The chip contains memory, ASCII character generator and LED multiplexing and drive circuitry. Each digit is 0.112" high. To load data to the DL-1414, you simply supply the desired data code to the D0 through D6 data inputs, select a digit address via inputs to the A0 and A1 address lines and execute a write cycle. Shown in Fig. 3 are the pinout details for the DL-1414. Figures 4 and 5 provide the block diagram and character-set logic for the LD-1414.

Listing 3. Driver Routine For LCD Display.

```
;*************************************************************
;
;LCD DISPLAY DRIVER
;
;EDTP 1994
;
;
;PROGRAM THE PIC16C55 WITH XT OSCILLATOR, WATCHDOG TIMER
;DISABLED, NO CODE PROTECT
;
;THIS ROUTINE IS BASED ON 4-MHz CLOCK
;
;*************************************************************

 INCLUDE "PICREG.EQU"

;********** PORT EQUATES
;
DATALINES    EQU  6        ;PORT B IS DATA BUS
CONTROL      EQU  5        ;PORT A IS CONTROL PORT

;********** BIT EQUATES
;
E            EQU  1        ;LCD ENABLE BIT
RS           EQU  0        ;INSTRUCTION/DATA INPUT BIT

;********** REGISTER EQUATES
;
LOOPY        EQU  8        ;LOOP REGISTER
OFFSET       EQU  9        ;OFFSET INTO MESSAGE TABLE
SPEED        EQU  0AH      ;SPEED OF SCROLL REGISTER

;*************************************************************
;
;PORT B LAYOUT
;
;RB0    DB0
;RB1    DB1
;RB2    DB2
;RB3    DB3
;RB4    DB4
;RB5    DB5
;RB6    DB6
;RB7    DB7
;
;PORT A LAYOUT
;
;RA0    RS
;RA1    E
;RA2    R/W
;
;*************************************************************

     ORG     0

BEGIN
     MOVLW        0              ;SET PORT A FOR OUTPUT
     TRIS         CONTROL
     TRIS         DATALINES      ;SET PORT B FOR OUTPUT

;********** INITIALIZE TO 8-BIT MODE 1-LINE DISPLAY
;
     MOVLW        0
     MOVWF        CONTROL        ;SET RS,R/W AND E LOW

     BSF          CONTROL,E      ;TAKE E HIGH
     MOVLW        30H            ;FUNCTION SET BYTE IS 30H
     MOVWF        DATALINES      ;PRESENT FUNCTION SET COMMAND
```

(Continued on page 102)

By David F. Norman

Enhancing Home Productivity with a Network

Setting up an inexpensive home local-area network with Artisoft's *Simply Lantastic*

According to a recent editorial in *MicroComputer Journal*, an astounding 37% of U.S. households have personal computers. What the report didn't mention was how many of these households have more than one computer in them. I'd hazard a guess that a fair percentage have more than one computer, each operating on its own, with no sharing of resources. This is inefficient and wasteful. Whenever a site—whether business or home—has more than one computer, it should be set up with a local-area network, or LAN.

Usually, when LAN is mentioned, the reference is to the business environment. Today, even very small businesses routinely use LANs to cut down on redundant data entry and permit sharing of computer resources. The day of the home network isn't far behind, thanks in no small part to fairly inexpensive hardware and software.

With so many of us working at home, and almost as many of us using computers in some form of telecommuting, there's should be no reason why any household with more than one computer isn't using a LAN to share resources. Even the cost factor shouldn't be a deterrent when you consider the advantages obtained because a small, full-featured network costs less than $200 per node, including hardware and software. Comparing this to the cost of another laser, ink-jet or letter-quality dot-matrix printer, you'll agree that the cost of setting up a LAN in the home is minimal.

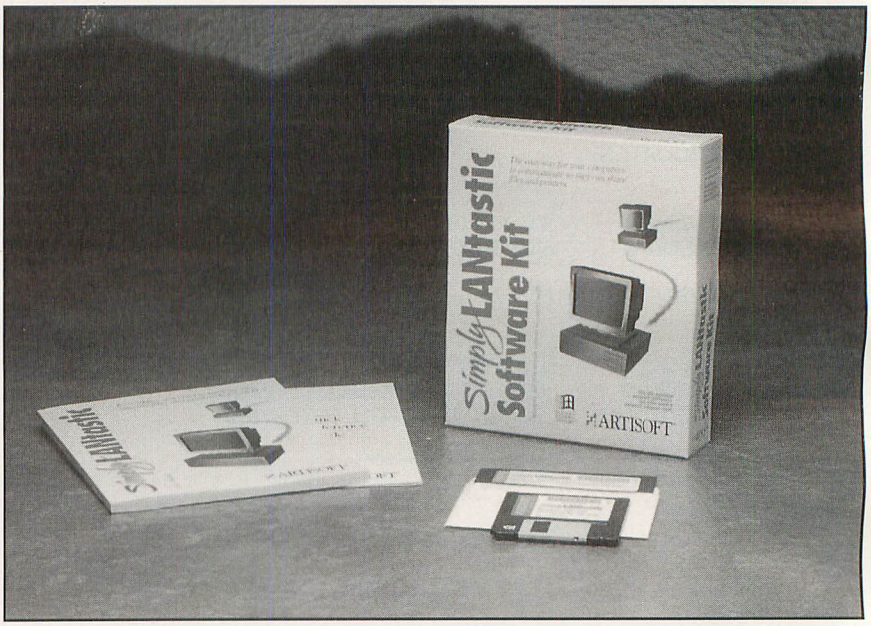


Fig. 1. *Simply Lantastic* is ideal for home office or multi-user personal computer systems.

Networking Basics

Networks are very simple in concept. With them, you can share disk drives, printers and CD-ROM drives with other nearby computers. Though the reality is somewhat more complex, someone else has done the hard part for you. Here's how it works.

Let's assume that mom or dad or both have a totally up-to-date computer system that includes a CD-ROM drive for reference purposes, a laser printer, a VGA monitor and a large-capacity and fast hard disk for file storage. Junior, on the other hand, has an old XT clone that has two floppy-disk drives, no hard disk and a cranky dot-matrix printer. If he has to share it with younger siblings, he probably isn't happy about the situation. Keeping "his" disks apart from "their" disks and trying to print a report on the slow old printer isn't conducive to efficient production. When he brings a disk of questionable origin to mom's or dad's "good" computer to print on the "good" printer, mom and dad aren't keen on the idea, either.

How is this for a solution? Plug a network card into Junior's machine and another in dad's computer. Interconnect the computers via the cards with a thin wire. Then install some simple software on both machines, and set it up so that Junior has his own subdirectory on dad's computer into which he can store files and programs. To Junior's machine, this subdirectory looks just like it has its own hard disk.

Having done the foregoing, Junior or dad can install the programs he uses in another subdirectory in his subdirectory. Remember that C:\JUNIOR on dad's machine looks like C:\ to Junior. Accessing the CD-ROM to research a paper requires

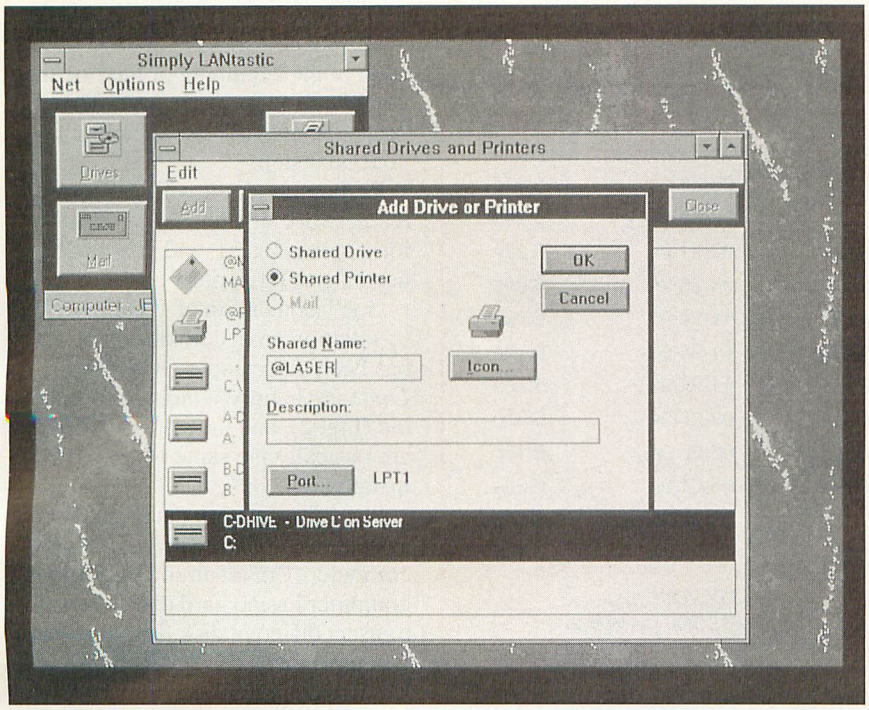


Fig. 2. From *Windows* or DOS, adding or deleting network connections is a very simple process.

only that the proper CD be in the drive's slot. If there are others who share his computer, the process can be duplicated for each user. Reports from Junior's machine are printed on the laser printer.

As long as access is limited by privileges granted through the network, the worst that can happen is that Junior's "hard disk" gets huge. An easy way to remedy runaway disk cramming is to partition one large disk into logical drives and assign Junior only so much room. The network software will cost Junior some free memory, which is no problem if he has 640K when he starts.

The cost to dad's computer in terms of memory is nil, assuming that his machine is powered by a 386 or 486 processor. Network software can easily be loaded into the high-memory area (HMA) between 640K and 1M using EMM386 or another memory manager. Dad will never notice a thing, other than the light blinking on his hard-disk drive.

Does this mean Junior can run any program on dad's computer? Probably not. There are two considerations involved when running software over a network. One is legal, the other operational.

Most software licensed for a single user can be installed on only one machine at a time. Without additional licenses, it's almost always illegal to share one copy of a software package. This doesn't mean that Junior's legal single-user copy of *Teen Avenger* can't be installed on a server for Junior to use on his machine. Such use is usually legal. What it does mean is that dad can't also play it on his machine. Policies vary from one software company to another and should be verified if any doubt exists.

Operational problems take many forms. Some programs will adapt to almost any type of video monitor and disk drive. Others require certain types of monitors, and some will run from or install to only a certain drive. Read the software documentation or check with the manufacturer. Some conflicts can be resolved easily, while others can't.

Up and Running

Networking household computers permits sharing of disk drives and peripherals, with increased productivity for all involved. If you're currently hand-carrying files from one computer to another for storage and printing, you're already using a form of networking called "SneakerNet."

Artisoft has a neat little product called *Simply Lantastic* (Fig. 1). This is a scaled-down version of and is compatible with the company's main product, *Lantastic*. The software comes bundled with network hardware (a small half-slot card) and runs on any IBM/compatible computer, even one that has no hard-disk drive. Unfortunately, the documentation for *Simply Lantastic* doesn't cover no-hard-disk installation. The following should remedy this oversight.

Each machine or node requires a separate software and hardware package. The program disks are serialized and come standard in both 3½" and 5¼" high-density disk formats. (If needed, low-density disks can be special ordered, but for our installation they won't be needed, even if Junior's computer has only a pair of 360K drives.)

For most systems, *Simply Lantastic* cards are plug-and-play. However, it may be necessary to add an "x" parameter to the EMM386 line in dad's CONFIG.SYS file. The modified file will look something like: DEVICE=EMM386 x=D000-DFFF. This parameter simply reserves a specific area of high memory for the network card. If you're running *Windows* on dad's computer, a similar line is needed in the SYSTEM.INI file in the C:\WINDOWS\SYSTEM subdirectory. This is about as complicated as it gets. All of this is fairly well spelled out in the documentation that comes with *Simply Lantastic*.

Install network cards in both SERVER and JUNIOR computers and interconnect them with cabling, as provided or specified by the documentation. Start with the computer, which I'll call SERVER, that will share its resources with other computers. Take a moment to decide exactly what you want to make available. Each package of *Simply Lantastic* has a planning sheet included in it. Use it now to avoid confusion later.

Before starting the installation, create a C:\JUNIOR subdirectory on the hard disk you wish to share with the workstation, which I'll call JUNIOR. This is the only area Junior can use as his own. If you're adding more workstations to the network, simply repeat the process for each one. *Simply Lantastic* has no password protection, but you can limit access as you choose.

```
Volume in drive A has no label
Volume Serial Number is 137A-19F1
Directory of A:\

COMMAND    COM        54,645    05-31-94    6:22a
AUTOEXEC   BAT           123    08-26-94    6:47p
CONFIG     SYS            83    08-26-94    6:44p
SHARE      EXE        10,912    05-31-94    6:22a
REDIR      EXE        54,231    08-26-94    6:09p
NET        MNU        89,413    11-24-93    5:10a
NET        HLP        51,992    11-24-93    5:10a
AILANBIO   EXE        20,81     11-24-93    5:10a
SETNET     BAT           321    08-26-94    6:31p
STARTNET   BAT         1,135    08-26-94    6:18p
WD8003     EXE         9,701    03-01-94    6:00a
CONNECT    BAT           276    08-26-94    6:54p
NET        EXE        18,609    11-24-93    5:10a
          13 file(s)              312,258 bytes
                                  819,200 bytes free
```

Fig. 3. Directory of JUNIOR boot disk showing minimum files necessary for *Simply Lantastic* workstation. NET.HLP, .MNU and .HLP files can be deleted after configuration is complete, but this isn't advisable. Note that this particular system uses WD8003.EXE as the hardware driver instead of NR.EXE. Almost any network card can be used with *Simply Lantastic,* as long as the driver is present and loaded before REDIR.EXE.

Place the installation disk in a floppy drive and log onto this drive. Then type INSTALL and hit Enter. This is a fairly smart installation program, but you'll experience several intervals during which you'll wonder if anything is going on at all. Don't worry, it's working just fine. At this time, the program will ask you several questions. In most cases, accept the defaults. When it asks you if you want to make permanent connections, you can either follow the prompts or wait until later. For now, just install the software and make connections later.

When installation is complete, rebooting the computer loads the network software. On 386 and 486 machines, the default is to load the network software into HMA. You may have to go back and modify the STARTNET.BAT file with an editor of your choice. *Simply Lantastic* installs an LED.EXE editor when it places the other software on your hard disk. This easy-to-use line editor is undocumented and presumably installed for technical-support purposes. Use it if you like, or delete it when you clean up after installation.

Check for available system memory using the command MEM/C|MORE. This will show you where the network software is loaded. If the network software loaded high, great! If it loaded into conventional memory, edit the STARTNET.BAT file located in the LANTASTI subdirectory. Simply deleting such parameters as "L:1..." on the line that loads the hardware driver ("NR" in a default installation) and in the lines loading AILANBIO, REDIR and SERVER will do the trick. When sharing a CD-ROM drive, MSCDEX.EXE with parameters must come after REDIR and before SERVER. Modify STARTNET.BAT accordingly, and delete the MSCDEX.EXE line from your AUTOEXEC.BAT file.

If you're proficient with MEMMAKER or another memory-shuffling program, use it after everything is working okay. For now, re-boot the computer and make certain that the net- work software has loaded high. If everything is okay, move on to the next step. If not, go back over the STARTNET.BAT file and see what you missed.

Now type NET and hit Enter. Choose the resources you wish to share. Make the printer available and set up C:\JUNIOR as another drive perhaps J:\ on_SERVER. Just follow the prompts.

One final step. Edit the AUTOEXEC.BAT file by placing a REM statement at the beginning of the line that would call STARTNET.BAT. This keeps the network from loading for your next step.

Re-boot SERVER without starting the network. It's time to build Junior's network disk, and you don't need anything in our way.

One last mention of *Windows*. The installation procedure discussed here has been made under DOS. *Simply Lantastic* is fully *Windows*-compatible (Fig. 2), and the steps described are basically the same for a *Windows* installation.

Place the network disk for Junior's system in the floppy drive in dad's computer (I'm assuming that Junior's computer has no hard disk). Be sure to use a different disk from the one you used for SERVER. Each disk is serialized and will work for only one machine on a network. Basically, this second—and any subsequent—installation is the same as before, with a few notable exceptions. Junior's computer will use SERVER's resources, but not the other way around. If Junior's computer has a printer that SERVER wants to share, JUNIOR would be installed as a server. Here, however, I'll assume that JUNIOR will be configured as a workstation only.

Accept the defaults until the program asks where you want to install the software. Give the program a name that's different from C:\LANTASTI, perhaps something like C:\LAN. When it asks for permanent connections make SERVER J:\ available as JUNIOR's C:\ and SERVER @PRINTER as JUNIOR's LPT2. This permits Junior to use the attached dot-matrix printer as LPT1. Don't worry if this doesn't all work perfectly the first time. Using SETNET after the program is installed allows you to get everything perfect.

Once the program is installed, place a floppy disk that will work in JUNIOR and boot. Remove all files other than COMMAND.COM and the two hidden system files. When boot-up is complete run a DIR command in the subdirectory in which you installed the software for Junior. If JUNIOR will read only a 360K disk, you must omit a few files.

For operation as a workstation, JUNIOR needs only STARTNET.BAT,

SETNET.BAT, CONNECT.BAT (if it exists), hardware driver NR.EXE, REDIR.EXE, AILANBIO.EXE and NET.* files. Delete C:\LAN, C:\LAN.NET and C:\TMP using DELTREE only after JUNIOR is up and running. Copy the necessary files onto JUNIOR's boot disk. Add SHARE.EXE to the boot disk.

After the files are copied, edit STARTNET.BAT to change any reference to C:\LAN or C:\DOS to A:\. Repeat the process with SETNET.BAT and CONNECT.BAT. This is a good time to build AUTOEXEC.BAT and CONFIG.SYS files for JUNIOR, if desired.

Place the disk in JUNIOR's floppy drive and boot up. At this point, you merely want to be sure the software loads and recognizes the network card. Until SERVER is running, JUNIOR won't be able to connect. If all's well, go back to SERVER and remove the REM statement from the AUTOEXEC.BAT file and re-boot to start the network. If a problem with JUNIOR crops up, retrace the steps until you resolve it.

When the network installs, re-boot JUNIOR and you should be in business. Run SETNET again on JUNIOR and get everything up to date. When you exit the program, a file called CONNECT.BAT is written or updated. CONNECT.BAT sets network connections when the network starts. Remember that SERVER must be running and the network installed before JUNIOR can access the drives and printers. Put a few common-sense rules on a sheet of paper to keep peace in the family.

Before sending a print job to the printer, JUNIOR's operator should check that the proper paper is installed. Most programs will reset the printer when they're through with it, but some older programs don't and can cause the next print job to be a mess. One thing that won't be a concern is mixing jobs. A print queue on SERVER will keep them in order. One possible exception might be a big print job coming from a very slow computer. If the print queue thinks the computer is through sending data, it will time out and go on with its business. Time-outs are adjustable if this is a problem. Mostly, things will move across the network flawlessly and transparently to all concerned.

If a CD-ROM drive is also shared, it goes almost without saying that the proper CD must be in place before it can be used by anyone. After a brief shakedown, priorities won't be a problem. The main thing is that JUNIOR is no longer a "stepchild." It's now a machine that's capable of serious computing chores.

If memory on SERVER permits, an easy way of further enhancing JUNIOR would be to make a large RAMDISK available on SERVER for JUNIOR's exclusive use. Many programs can take advantage of a RAM drive for temporary or sort files. Bear in mind, however, that programs running on JUNIOR can operate no faster then JUNIOR's processor will permit, no matter how fast SERVER might be.

In Closing

If your initial experiment with a home network is as successful as it should be, you might want to consider adding other computers. There are a lot of inexpensive used computers sitting out there looking for homes. Even in this age of 486- and Pentium-powered machines, you can do a lot of serious computing with a 286, which you can buy complete with hard disk and VGA monitor for $200 to $300.

For home-office/personal use, small inexpensive networks like *Simply Lantastic* have come of age as a productivity tool. The savings realized by being able to share expensive peripherals will easily justify the cost of networking. ■

By Paul Bergsman

Make Your PC Operate as a Multiple Metering Device

A simple interface device connected to its parallel printer port lets your PC meter voltage, velocity, pressure, temperature or any other physical property for which you can find a sensor—as many as eight of them simultaneously

You may not realize it, but your computer's parallel printer port can input as well as output data. All IBM and compatible parallel printer ports have eight lines on which data is transmitted to a printer. Also, all such printer ports have nine lines for feeding data into the computer. One of the more-interesting things you can do with this printer port is to use a circuit that inputs eight-bit data. Such a circuit can convert a voltage to a binary number and input this value to your computer via the parallel printer port.

Several years ago, such conversion circuitry would have required a lot of components, a week to design and another week to build and debug. In this article, I'll describe how to connect inexpensive single- and eight-channel analog-to-digital (A/D) converters to your computer.

An A/D converter is your window to the world of analog devices. By utilizing a handful of inexpensive components, you can turn your computer into a metering device for measuring any physical parameter for which you can locate a sensor, as described here. I'll describe how you can build a circuit that meters a single parameter and another that meters up to eight parameters simultaneously.

Many sensors output an analog voltage that's proportional to temperature, resistance, pressure or frequency. The sensor's output becomes the A/D converter's input. The converter "reads" the voltage, compares it to a reference, generates a descriptive binary number and outputs the resulting number to your computer.

Manufacturers have started shipping laptops with bidirectional parallel printer ports. This practice isn't standard and pertains to only laptops. However, the material presented here will work with *any* IBM/compatible printer port, including those bidirectional ones in laptops.

Two Ways to Do It

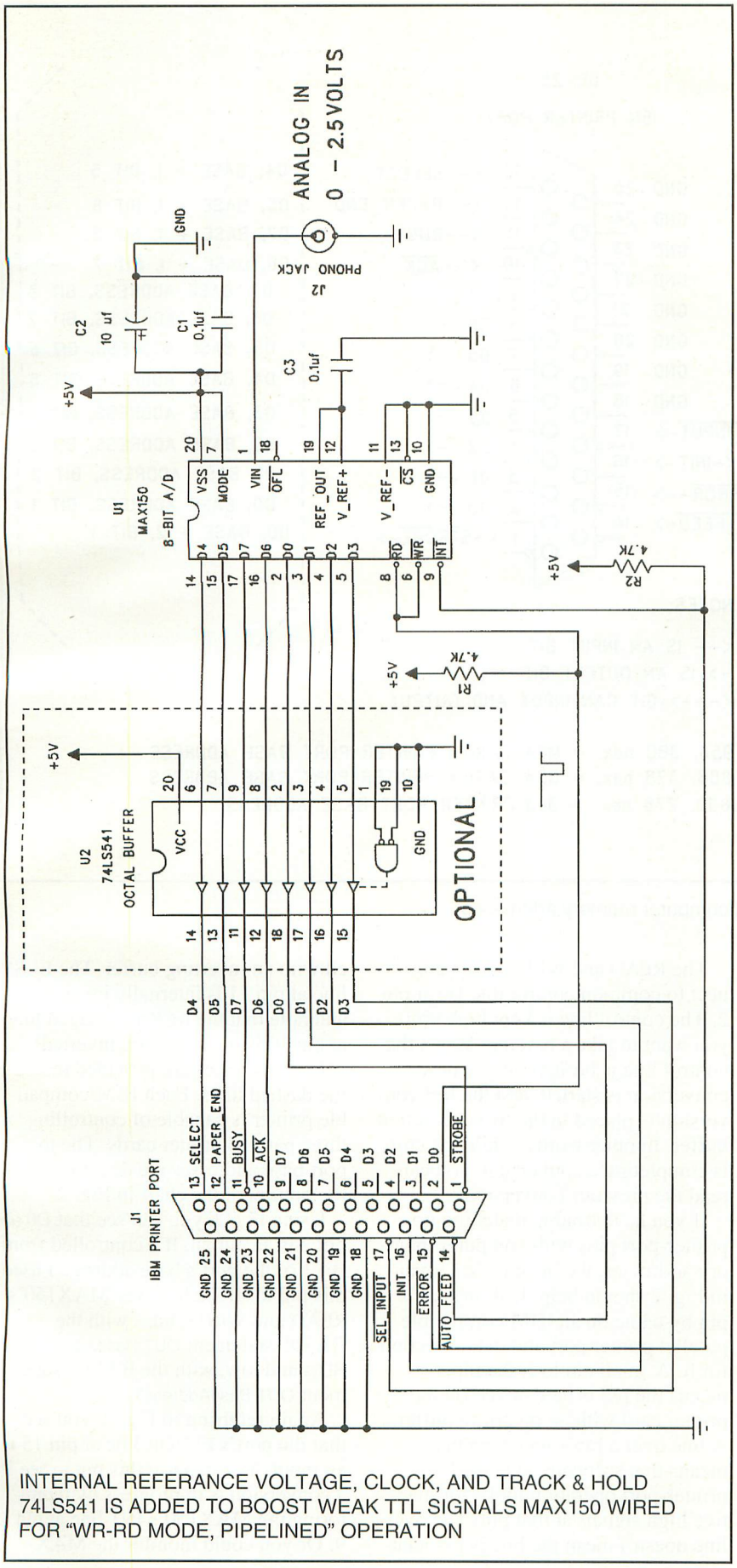
The ADC0804, which sells for about $3.95 from Digi-Key, is a tried-and-true A/D converter. It reads a voltage and converts it to an eight-bit binary number. (Complete circuit details and software to interface the ADC0804 to a parallel printer port are provided in my book, *Control the World With Your PC*, from HighText Publishers.)

The ADC0804 isn't without drawbacks, of course. Its major limitation is speed. Using an .EXE file compiled from Borland's Turbo Pascal, I was able to read a maximum of only 2,000 samples per second. Of course, this number can be boosted by using assembly language. But no matter what clever tricks you use, the ADC0804 will remain a slow A/D converter. It was designed as an inexpensive general-purpose device and, as such, is more than adequate for many less-demanding applications.

The ADC0804 divides an external reference voltage into eight binary-proportional divisions. It then compares the input voltage to each subdivision. Thus, it takes eight consecutive compare operations to determine the input's value. Though the process is slow, if you want to take a *periodic* voltage, temperature, frequency or pressure reading, the ADC0804 may offer a realistic solution for your design needs. As long as your input's value changes slowly over time, the ADC0804 is a cost-effective solution.

No matter how you look at it, though, the technology utilized in the ADC0804 is dated by modern standards. In this article, I describe a more-modern eight-bit A/D converter. The MAX150 from Maxim has an internal voltage reference and an on-board clock and can complete a conversion in 3.6 µs! By adding only two capacitors, you can build a quality high-speed data-logging A/D converter. Fast-changing frequency, voltage and pressure readings are now possible with this handy device. With a rate of 300,000 samples per second possible, you can make digital-audio recordings or analyze fast-changing transient voltages.

Some on-board ultramodern high-tech circuitry is what makes the MAX150 fast. First, it grabs a sample of the input with a track-and-hold (T/H) circuit. Then it uses two four-bit flash A/D converters to make eight simultaneous comparisons. Finally, the component count of a design is minimized by Maxim equipping the MAX150 with an internal reference voltage and internal clock.



INTERNAL REFERANCE VOLTAGE, CLOCK, AND TRACK & HOLD 74LS541 IS ADDED TO BOOST WEAK TTL SIGNALS MAX150 WIRED FOR "WR-RD MODE, PIPELINED" OPERATION

Fig. 1. A MAX150 interfaced to an IBM-type parallel printer port.

PARTS LIST

For MAX150.SCH Eight-Bit Single-Channel Interface

Semiconductors

U1—MAX150BCPP eight-bit A/D converter ($16.92 each, Maxim Integrated Products; tel.: 1-800-998-8800)

U2—74LS541 octal buffer

Capacitors

C1,C3—0.1-µF, 15-volt

C2—10-µF, 15-volt

Resistors

R1,R2—4,700 ohms, 1/8-watt

Miscellaneous

J1—Right-angle pc-mount female subminiature D-shell connector (Digi-Key Cat. No. 625F-ND)

J2—Phono jack, BNC connector or equivalent

Printed-circuit board (see Note below);

Note: Available from author (see below): MAX150-BOARD. An assembled and tested circuit-board assembly with on-board regulated 5-volt dc power supply, 9-volt battery connector and sample software for IBM/compatible computers (requires 6-to-12-volt battery supply), $45 post paid.

General Description

Show in Fig. 1 is a schematic diagram of a MAX150 interfaced to an IBM-type parallel printer port. Since the chip is designed to operate from a single 5-volt supply, pins 20 and 10 are connected to +5 volts and ground, respectively. The analog signal is input between V_{in} at pin 1 and ground. The analog input can vary between 0 and +5 volts.

Chip-Select (CS) line pin 10 ties to ground. With this line always low, the MAX150 is always active and operates according to the logic levels of the Read (RD) and Write (WR) lines at pins 8 and 6, respectively.

Though explaining how to do it is beyond the scope of this article, you could multiplex several MAX150s to a single parallel printer port by adding hardware. For example, a 74LS139 one-of-four decoder lets you multiplex four devices. Similarly, a 74LS538 lets you multiplex eight devices.

The four low-nibble data bits at printer port pins 1, 14, 16 and 17 require a relatively large amount of power to assure proper operation. Even when the manufacturer of

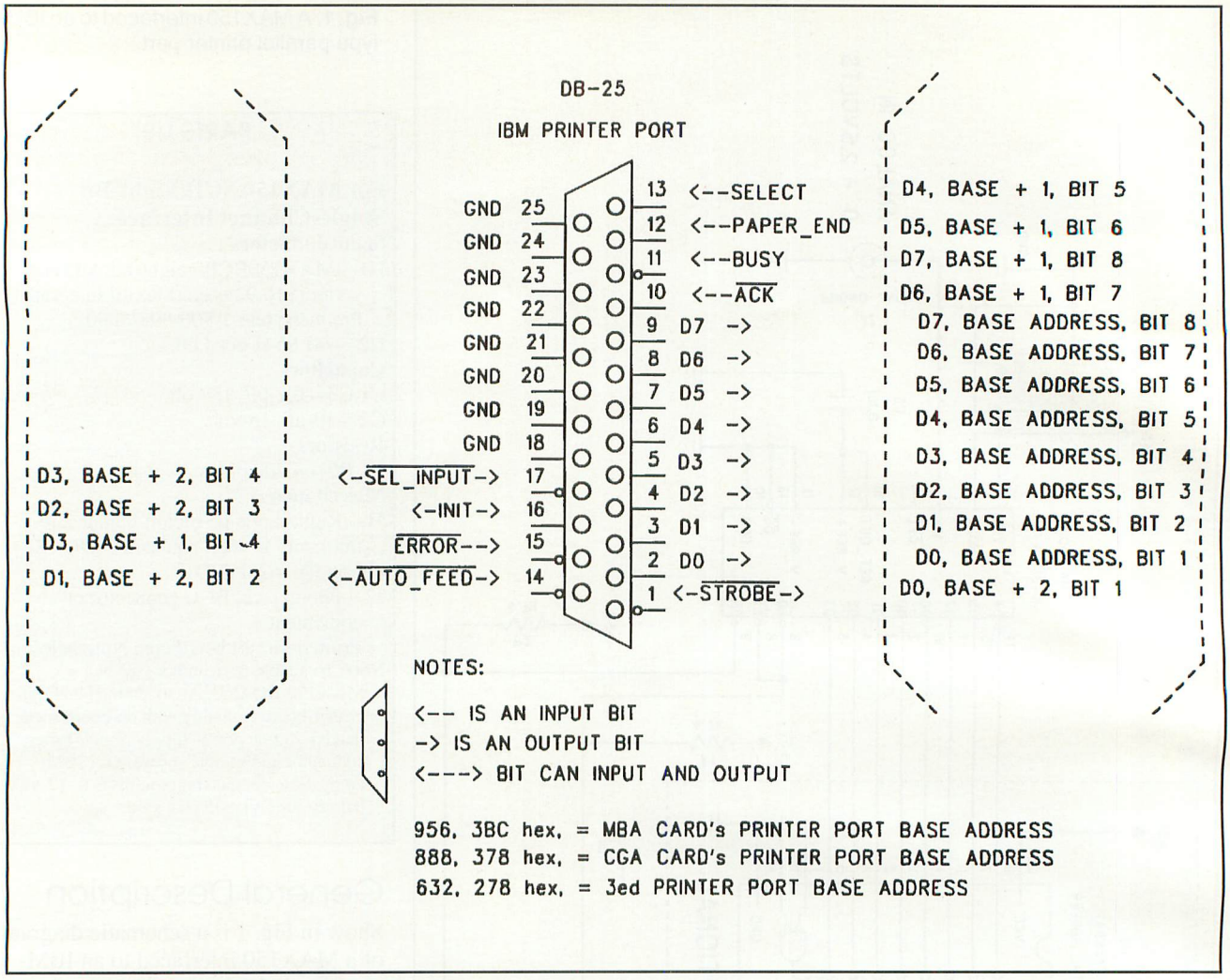


Fig. 2. Printer-port pins and their related computer memory addresses.

CMOS chips states that the outputs are low-level TTL-compatible, they may not have enough power to drive these pins. To obviate this problem, I added a 74LS541 noninverting buffer to the circuit.

Even if your computer doesn't require the extra buffering, including it lets you run longer interconnecting cables between your project and the printer port. Usable cable length can also be stretched by adding 4,700-ohm pull-up resistors to every printer-port input and output pin.

Data sheets for the MAX150 describe several methods of control. The simplest method for interfacing the chip to a parallel printer port is to hard-wire the chip for Write-Read mode Pipelined operations, as explained on page 1-48 in the MAX150 manual. You tell the chip to use this mode by tying high the Mode-Select line at pin 7.

The READ and WRITE lines connect to common control line D0 at pin 2. The control line is kept high until you want to take a reading. When the control line is brought low, a new conversion is started, and the last conversion is placed in the tri-state output buffer. In other words, while the chip is completing a conversion, you can read the previous conversion.

If you have trouble matching up printer-port pins with computer memory addresses, the information given in Fig. 2 should help. It shows each pin by name on an IBM/compatible parallel printer port and data direction for it. A small circle at the input means the pin is hard-wired on the printer card with an inverting buffer. A line over a pin's name simply means that software dedicated to printer-port operation looks for inactive high signals at that pin. The overline doesn't mean the line is associated with an inverting buffer. The BUSY line at pin 11 is internally inverted, and note that the ACKnowledged line at pin 10 is *not* hardware inverted!

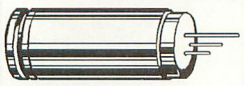
Port addresses are provided inside the dashed lines. Each IBM/compatible printer is capable of controlling three parallel printer cards The three port base addresses are documented at the bottom of the chart in Fig. 2.

Using Fig. 2, you can see that D0 at pin 2 is an output. It's controlled from Bit 1 of the port's base address. I used this pin to strobe high the MAX150's READ and WRITE lines with the BASIC statement OUT BaseAddress%, RD% and low, with the BASIC statement OUT BaseAddress%, 0.

Again referring to Fig. 2, you see that the port's ERROR line at pin 15 is an input. You can use this pin to see if a conversion is in progress by monitoring the MAX150's INT line at pin 9. Or you could monitor the MAX-

Celebrating our 12th Year Of Service !!

Collimator Pen



Output: 2.5 mW (max.); Current 90-150 mA
Oper. Volt: 2.2-2.5 V; Wl: 820 nm - Infrared
Size: 11 mm dia. x 27 mm L; Data sheet inc.

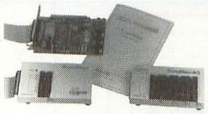
Stock#	1-9	10-24	25+
SB1052	49.99	47.49	42.74

Collimating Lens

Black anodized aluminum barrel; Glass lens with 7.5mm focal length. Fits 9mm laser diodes sold below. easy to focus and install.

Stock#	1-9	10-24	25+
LSLENS	24.99	23.74	21.37

Eprom Programmer



Programs all EPROMS, EEPROMS, including flash memories. Programs microcontrollers with optional adapters. Complete with software, programming module, cable & manual. Single Device programming.

Stock#	1-9	10-24	25+
ROMMAX	149.99	142.49	128.24

Eprom Eraser

Shirt pocket size handles up to 4 devices at a time. Auto start, erases most EPROMs/EPLDs in 3 minutes. Molded plastic case.

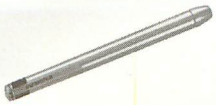
Stock#	1-9	10-24	25+
DE2	39.99	37.99	34.19

Universal Programmer

Programs PROM, EPROM, EEPROM, Flash EPROM, serial PROM (8 pin), bipolar PROM, PLD, GAL, PAL, EPLD, PEEL, and microcontroller. Tests logic ICs (TTL/CMOS), and memory (DRAM/SRAM).

Stock#	1-9	10-24	25+
ALLMAX	499.99	474.99	427.49

Laser Pointer



- < 4 mW output
- 0.5" dia. x 5" long
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Stock#	1-9	10-24	25+
NBK	59.99	56.99	51.29

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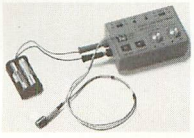

Stock#	1-9	10-24	25+
VLDM	159.99	151.99	136.79

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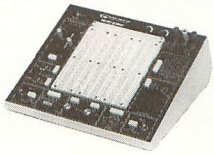

Stock#	1-9	10-24	25+
PB503	259.99	246.99	222.29

Laser Diodes

Stock#	Mfr.	Wavelength	Output	1-9	10-24	25+
LS9520	Toshiba	635nm	3 mW	139.99	132.99	119.69
LS9321	Toshiba	650nm	5 mW	99.99	94.99	85.49
LS9200	Toshiba	670nm	3 mW	29.99	28.49	25.64
LS9211	Toshiba	670nm	5 mW	39.99	37.99	34.19
LS9215	Toshiba	670nm	10 mW	79.99	75.99	68.39
LS9140	Toshiba	685nm	20 mW	169.99	161.49	145.34
LS022	Sharp	780nm	5 mW	17.99	17.09	15.38
SB1053	Phillips	820nm	10 mW	10.99	10.44	9.40

Laser Pointer

- Swivel head
- 670nm
- > 4 mW output
- Weighs less than 2.5 oz.
- Size approx. 4" L x 2" W x 0.75" D
- Dual mode - continuous/blink
- Visible up to 150 ft.
- Runs on 2 AAA batteries

Stock#	1-9	10-24	25+
GALET	59.99	56.99	51.29

Robotic Arm Kit

Fascinating and educational, with lift/lower, grab/release, and pivot left/right functions. Uses 2 C batteries (not inc.); approx. 10" long. Use Y01IBM interface to program from your PC!

Stock#	1-9	10-24	25+
Y01	43.99	41.79	37.61
Y01IBM	35.99	34.19	30.77

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- Control - air propelled, direct motor drive, or solar battery (sold separately)
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Stock#	1-9	10-24	25+
OWI655	14.99	14.24	12.82

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SB1100	2.99	2.84	2.56

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- Fits all 9 mm laser diodes

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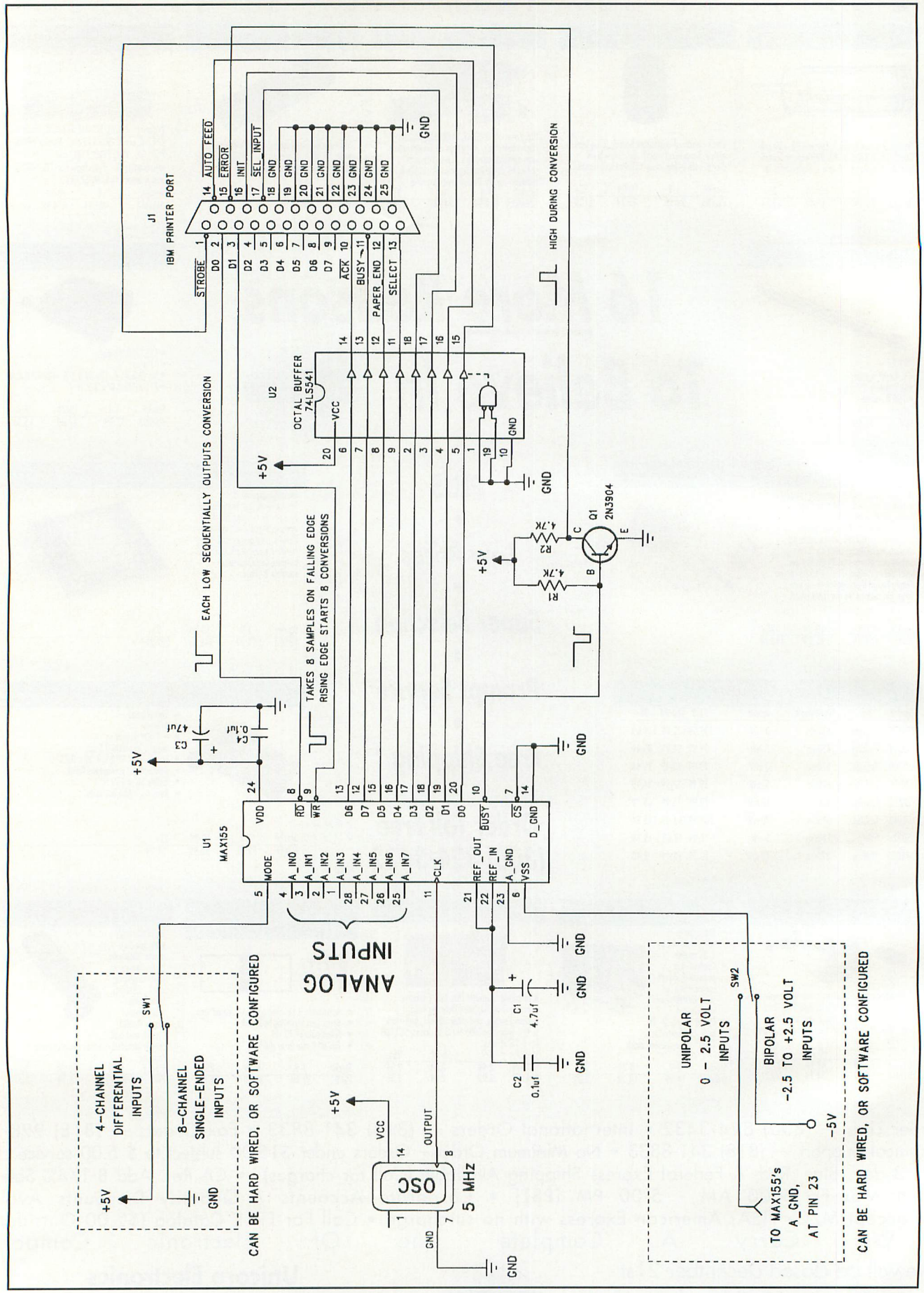

J1
IBM PRINTER PORT
STROBE
D0
D1
D2
D3
D4
D5
D6
D7
ACK
BUSY
PAPER_END
SELECT
AUTO_FEED
ERROR
INIT
SEL_INPUT
GND
U2
OCTAL BUFFER
74LS541
VCC
+5V
EACH LOW SEQUENTIALLY OUTPUTS CONVERSION
TAKES 8 SAMPLES ON FALLING EDGE
RISING EDGE STARTS 8 CONVERSIONS
HIGH DURING CONVERSION
Q1
2N3904
R1
4.7K
R2
4.7K
C3
47uf
C4
0.1uf
U1
MAX155
VDD
RD
WR
BUSY
CS
D_GND
MODE
A_IN0
A_IN1
A_IN2
A_IN3
A_IN4
A_IN5
A_IN6
A_IN7
CLK
REF_OUT
REF_IN
A_GND
VSS
ANALOG
INPUTS
C1
4.7uf
C2
0.1uf
OSC
5 MHz
OUTPUT
4-CHANNEL
DIFFERENTIAL
INPUTS
8-CHANNEL
SINGLE-ENDED
INPUTS
SW1
CAN BE HARD WIRED, OR SOFTWARE CONFIGURED
UNIPOLAR
0 - 2.5 VOLT
INPUTS
BIPOLAR
-2.5 TO +2.5 VOLT
INPUTS
SW2
-5V
TO MAX155's
A_GND,
AT PIN 23
CAN BE HARD WIRED, OR SOFTWARE CONFIGURED

Fig. 3. This circuit illustrates the simplicity of interfacing a MAX155 to a parallel printer port.

For MAX155.SCH Eight-Bit, Eight-Channel Interface

Semiconductors

Q1—2N3904 npn transistor

U1—MAX155BCPI, eight-channel, eight-bit A/D converter ($18.79 from Maxim Integrated Products; tel.: 1-800-998-8800)

U2—74LS541 octal buffer/line driver (Digi-Key Cat. No. 74LS541, 74F5341 or equivalent)

X1—5-MHz crystal oscillator (Digi-Key Cat. No. X109)

Capacitors

C1—4.7-µF, 15-volt

C2,C4—0.1-µF

C3—47-µF, 15-volt

Resistors

R1,R2—4,700 ohms, 1/4-watt

Miscellaneous

J1—Subminiature D-shell connector

SW1,SW2—Spdt switch (included for circuit clarity; hard wire MODE and V_{SS} pins as needed)

Printed-circuit board (see Note below;)

Note: Available from author: MAX155-BOARD. An assembled and tested circuit board with on-board regulated 5-volt power supply, 9-volt battery connector and sample software for IBM/compatible computers. Requires 6-to-12-volt battery supply, $60 postpaid.

Paul Bergsman
521 E. Wynnewood Rd.
Merion Station, PA 19066-1345
Tel.: 610-667-2449

Digi-Key Corp. Tel.: 1-800-344-4539

Listing 1. Quick Basic Sample Program Inputs Eight-Bit A/D Conversions to a Computer via its Parallel Printer Port.

```
REM   MAX150, 8-BIT A/D CONVERTER, INPUT THROUGH PARALLEL PRINTER
PORT
REM   programed by Paul Bergsman in QBASIC.
REM
REM   (c) 1994, by Paul Bergsman, all rights reserved
REM
REM   RD and WR lines are tied together.  When WR line goes from from an
REM   inactive high to an active low, a conversion is started. While the RD
REM   line is at active low, the tri-state output buffer places the last
REM   conversion result on the data output lines.  By tying both RD and WR
REM   lines together, you start a new conversion while reading the last
REM   conversion. Maxim calls this RD-WR Mode, "Stand-Alone-Operation".

RD% = &H1: REM D0, AT BASE ADDRESS, USED TO CONTROL ADC0804'S READ
LINE
CLS
WHILE INKEY$ = ""
  BaseAddress% = 632: REM = 3ed IBM/compatible PRINTER PORT
    REM USE 956 FOR MGA CARD'S PRINTER PORT, & 888 FOR CGA CARD'S
PRINTER PORT

  REM  input data-byte from A/D via parallel printer port
  OUT BaseAddress%, 0: REM bring RD and WR lines LOW
  HighNibble% = INP(BaseAddress% + 1) AND &HF0
  HighNibble% = HighNibble% XOR &H80
  OUT (BaseAddress% + 2), &H4Quick Basic sample program that inputs eight-bit A/D
conversions to your computer via an IBM/compatible parallel printer port.
  LowNibble% = INP(BaseAddress% + 2) AND &HF
  LowNibble% = LowNibble% XOR &HB
  BinDisplay% = HighNibble% OR LowNibble%

  REM DISPLAY READING
  volts# = (5 * BinDisplay%) / 255
  volts# = INT(volts# * 100) / 100
  LOCATE 5, 5
  PRINT "RAW BINARY VALUE = "; BinDisplay%; ";       ";
  PRINT "EQUIVALENT VOLTS = "; volts#; ""

  OUT BaseAddress%, RD%: REM return RD and WR lines to inactive HIGH
WEND
END
```

150's, OFL overflow line at pin 18, which goes low if the analog input is greater than 5 volts.

Listing 1 is a Quick Basic sample program that inputs eight-bit A/D conversions to your computer via an IBM/compatible parallel printer port. I personally prefer Pascal, and I know many of you have a passion for C. However, you need a compiler for these languages. Also, the QB listing is clear enough that programmers can easily convert this code to C or Pascal. It would be difficult for a novice to convert a Pascal or C listing to BASIC.

A good rule for circuit design is to keep it simple. The circuit for the MAX150 is as simple as it gets. However, at some point, you may have a project that requires you to simultaneously monitor several analog devices. Instead of designing your own multiplexing circuit, you can purchase off-the-shelf multi-channel A/D converters.

The MAX155 contains eight track-and-hold circuits that simultaneously sample eight analog inputs. It contains an on-board reference and can be software- or hardware-controlled to accept single-ended or differential analog inputs and accept unipolar or bipolar input ranges. It can digest 250,000 samples per second. For many applications, it will operate from a single 5-volt dc supply.

Illustrated in the schematic diagram shown in Fig. 3 is the simplicity of interfacing a MAX155 to a parallel printer port. Switches *SW1* and *SW2* connected to the MAX155 are shown here only for clarity. You can hard-wire MODE and V_{SS} pins 5 and 8, respectively, to their appropriate power sources. Together, the two switches determine the kind of analog inputs you'll use.

Most A/D converters require you to build conditioning circuits to place in front of the converter's analog input. This can become quite a chore. You must find matched components and then design, build and test the design. The MAX155 saves you time, money

Listing 2. Quick Basic Program Input Data Readings and Displays Results on Your PC's Video Screen.

```
10 REM 8-Channel, 8-bit A/D using a MAX155 A/D converter
   REM MAX155 HARD WIRED FOR 8-CHANNEL, UNIPOLOR, INPUTS
   REM
   REM WRITTEN IN Quick Basic by Paul Bergsman
   REM (C) 1994, by Paul Bergsman, ALL RIGHTS RESURVED

20 RD% = &H2: REM D0, AT BASE ADDRESS, USED TO CONTROL MAX155'S READ LINE
   WR% = &H1: REM D1, AT BASE ADDRESS, USED TO CONTROL MAX155'S WRITE LINE
   busy% = &H8: REM D3, AT BASE + 1, MONITORS MAX155'S BUSY LINE
   BaseAddress% = 888: REM = CGA PARALLEL PRINTER PORT'S BASE ADDRESS
                 REM USE 956 FOR MGA CARD, & 632 FOR THIRD PRINTER PORT

90 REM   display header
   CLS
   PRINT "-=[ MAX155 8-CHANNEL, 8-BIT A/D CONVERTER OUTPUTS ]=-"
   PRINT
   PRINT "CHANNEL NUMBER", "BINARY VALUE", , "VOLTAGE"
   PRINT

100 REM Input data-byte from A/D via parallel printer port

110 REM Initilize printer port
      OUT BaseAddress%, WR% + RD%: REM              00000011

120 REM TELL MAX155 TO TAKE EIGHT TRACK & HOLD SAMPLES
    OUT BaseAddress%, WR%: REM                      00000010

125 REM WAIT UNTIL ALL 8 CONVERSIONS ARE COMPLETE
    Temp% = INP(BaseAddress% + 1)
    IF (Temp% AND Busy%) = Busy% THEN GOTO 125

130 REM DO 8 CONVERSIONS FORM 8 TRACK AND HOLD SAMPLES
    OUT BaseAddress%, (WR% + RD%): REM              00000011

150 REM READ AND DISPLAY 8 CONVERSIONS
    FOR CT = 0 TO 7

      REM PUT CONVERSION IN MAX155'S TRI-STATE OUTPUT BUFFER
      OUT BaseAddress%, RD%: REM                    00000001

      REM READ 8-BIT VALUE INTO COMPUTER
      REM input high nibble
151   HighNibble% = INP(BaseAddress% + 1) AND &HF0
152   HighNibble% = HighNibble% XOR &H80

      REM set (base address +2) open collector ouputs HIGH
      OUT (BaseAddress% + 2), &H4

      REM input low nibble
153   LowNibble% = INP(BaseAddress% + 2) AND &HF
154   LowNibble% = LowNibble% XOR &HB

      REM COMBINE NIBBLES INTO DATA BYTE
155   DataByte% = HighNibble% OR LowNibble%
      OUT BaseAddress%, (WR% + RD%): REM            00000011

156   REM DISPLAY DATA
      LOCATE ((CT * 2) + 6), 1
      Volts# = (2.5 * DataByte%) / 255
      Volts# = INT(Volts# * 1000) / 1000
      PRINT "       "; CT; ")", , DataByte%, , Volts#; " volts;   ";
      IF INKEY$ <> "" THEN STOP

160 NEXT CT
    GOTO 100
200 END
```

and frustration. All front-end conditioning circuitry is inside the chip itself. You can select a front-end from software or by hard-wiring the control pins.

Switch *SW2* selects between unipolar and bipolar operation. Both unipolar and bipolar signals are referenced to ground. In unipolar operation, the signal always varies above ground. In the case of the MAX155, the input signal can vary between 0 and +2.5 volts. In bipolar operation, the input signal varies above and below ground. In the case of the MAX155, input signals can vary between +2.5 and –2.5 volts.

Switch *SW1* selects between SINGLE-ENDED and DIFFERENTIAL mode. In SINGLE-ENDED mode, one side of each input signal is tied to ground, making available eight input channels. In DIFFERENTIAL mode, each end of the input signal is connected to an analog input. Therefore, four input signals require eight analog input channels.

Differential inputs offer a very high degree of amplification, often greater than 100 dB. The differential inputs aren't connected to ground. Instead, they're allowed to float. Differential amplifiers are also used as instrumentation amplifiers and can be used to monitor balanced low-impedance microphones, telephone lines and strain gauges.

If you select the differential input of the MAX155, be aware that it's a pseudo-differential input. The chip creates a negative mirror-image signal that changes very slowly. Maximum negative movement of the input signal must be less than one LSB (least-significant bit) per reading.

Examples of each type of input are shown in Fig. 4. The circuit is from the MAX155 data sheet.

Although telling you how to do it is beyond the scope of this article, you can leave floating the MODE and V_{SS} lines at pins 5 and 6, respectively, and select a front-end configuration from software.

Since the output lines of the MAX-155 are bidirectional, your computer can send the MAX155 a control word that tells it which input you want to use and the kind of signal it's reading. In other words, different types of input signals can be read at the same time, selected by your software. This chip is a gem!

The 74LS541 buffer amplifies the weak MAX155 output signals. Transistor *Q1* amplifies the chip's BUSY signal. If the connecting cable is short, you may not need *U2* or *Q2*.

Because of high operating speeds, the MAX155 requires an external crystal oscillator. An RC network like the one used on the ADC0804 just won't cut it here. You must supply the oscillator, which is a small inconve-

nience, considering all the other packaged goodies.

Referring back to Fig. 3, I shorted the MAX155's MODE line at pin 5 to ground and V_{SS} line at pin 6 to A-GND at pin 23 so that the chip is hard-wired for eight-channel unipolar operation. An assembled and tested circuit board, detailed in the Parts List, uses space-efficient jumpers to set the analog input parameters.

The following discussion is relevant for only eight-channel unipolar hard-wired operation, with MODE pin 5 shorted to ground and V_{SS} shorted to A-GND pin 23. This is by far the simplest method of interfacing the MAX-155 to a parallel printer port.

For test purposes, I used eight 10-turn potentiometers to straddle a 2.5-volt power supply. The wiper of each pot connects to the corresponding analog input pin (pins 1 through 4 and 25 through 28) of the MAX155.

Taking a reading is almost too easy. The RD line at pin 8 and WR line at pin 9 do all the work, as follows:

(1) Both lines are brought to logic high.

(2) The WR line is brought low, which tells the MAX155 to simultaneously sample all eight inputs with its eight internal track-and-hold circuits.

(3) The WR line is brought high to tell the MAX155 to perform eight conversions of the eight T/H samples. The BUSY line at pin 10 remains low while conversions are in progress. Results of all the conversions are automatically stored in the MAX155's memory.

(4) The program must now wait about 26 µs so that the MAX155 can complete eight conversions. You could code a software-driven delay loop, or you could monitor the MAX155's BUSY line at pin 10. The BUSY line's output is low during conversions.

(5) The RD line at pin 8 is brought low and, in response, the MAX155 places the contents of a memory location in the tri-state output buffer.

(6) The computer reads the value in the tri-state buffer via its parallel printer port.

(7) Steps (5) and (6) repeat eight times.

(8) Steps (5) and (6) repeat seven more times to input the remaining seven A/D conversions.

The Quick Basic Program given in Listing 2 performs all the steps listed above. Input data is digested and displayed on your PC's video screen.

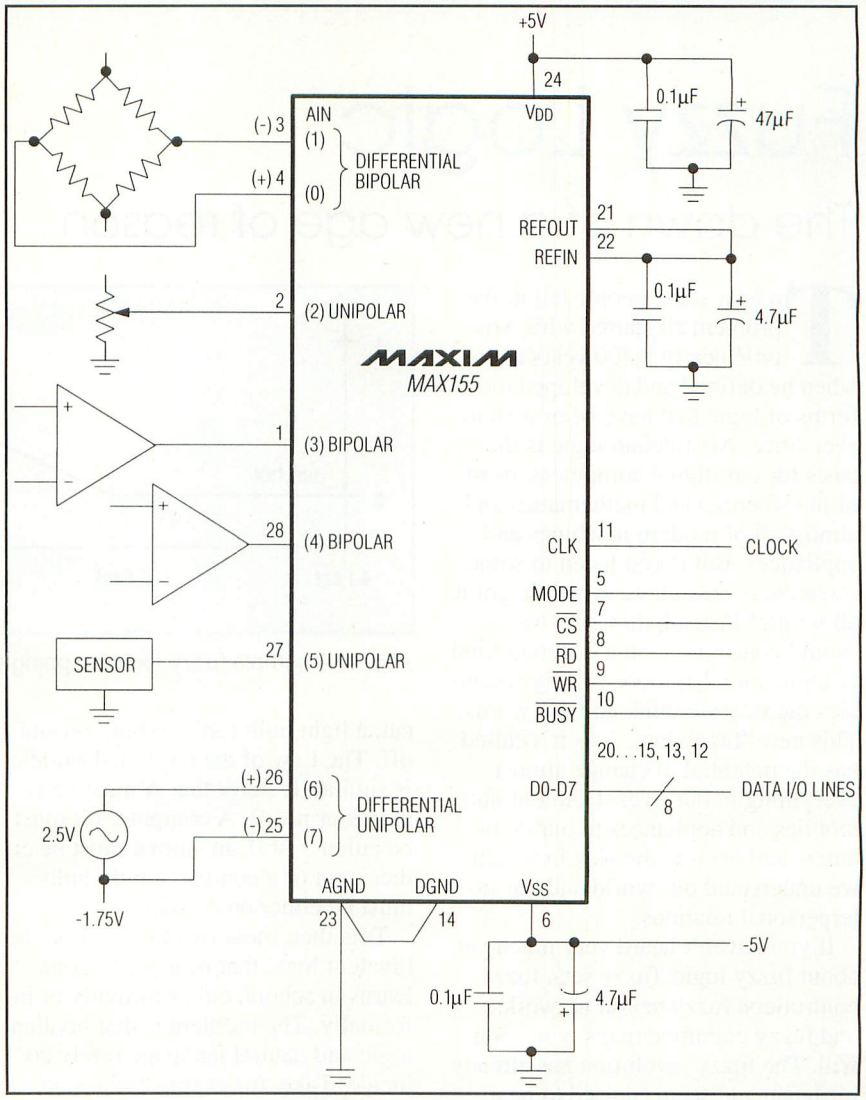


Fig. 4. Shown here are examples of each type of input that can be applied to a MAX155 8/4-channel ADC. **(Courtesy Maxim Integrated Products)**

The printer port uses some bits from (base address + 1) and still other bits from (base address + 2). The MAX-155 and MAX150 connect to the printer port so that the high conversion nibble bits are read from (base address + 1) and the low nibble conversion bits are read from (base address + 2). Some software logic operations sort out everything.

Since the parallel printer port's input lines were designed to keep track of printer operations, some of the port's pins are hard-wired with inverter buffers for inactive high logic operations. Listing 2 not only reads in the raw data, it re-invents the inverted logic bits.

In line 151, the logical AND operator isolates the (base address + 1) high nibble, and the low nibble from (base address + 2). In line 152, the logical XOR operator re-invents the low-nibble inverted bits. Line 153 again uses the logical AND operator to isolate the low nibble bits, and line 154 again uses the logical XOR operator to re-invert the low nibble's inverted input logic.

Line 155 uses the logical OR operator to combine the high and low nibbles into a useful data byte, labeled DataByte%.

In an upcoming issue, I'll give you a look at 12-bit single-channel and 12-bit multi-channel A/D converters that can efficiently interface to a parallel printer port. ■

By Hardin Brothers

Fuzzy Logic

The dawn of a new age of reason

To hear some people tell it, the problem all started with Aristotle nearly 2,400 years ago, when he defined and developed the forms of logic that have been with us ever since. Aristotelian logic is the basis for our digital computers, most of our sciences and mathematics and almost all of modern machines and appliances. But if you listen to some researchers nowadays, Aristotle got it all wrong! Instead, they say, we should concentrate on a different kind of logic, one that more-closely resembles the way we think and use words. This new "fuzzy logic," as it's called, has the potential to change almost everything in our lives, from our automobiles and appliances to our computers and even to the way in which we understand our world and our interpersonal relations.

If you haven't heard very much yet about fuzzy logic, fuzzy sets, fuzzy controllers, fuzzy neural networks, and fuzzy cognitive maps, you soon will. The fuzzy revolution has already hit Japan and seems poised to be a major engineering and marketing force in the U.S. as well. Fuzzy logic has been discussed in both popular and technical publications. However, articles in the popular press tend to be overblown and those in the technical press are often more filled with obscure math than solid information.

Foundation of Fuzzy

Classic logic is based on the writings of Aristotle and his contemporaries. While there were arguments about its axioms during Aristotle's time, they really weren't challenged until about a century ago.

Two fundamental axioms of Aristotle's formal logic seem so self-evident that they defied examination. The Law of Contradiction states, in symbolic form, that A cannot be both B and not-B at the same time. A computer bit cannot be both 0 and 1, an animal can't be both a cat and a non-cat, a light bulb can't be both on and off. The Law of the Excluded Middle is similar. It states that A must be either B or not-B. A computer bit must be either 1 or 0, an animal must be either a cat or a non-cat, a light bulb must be either on or off.

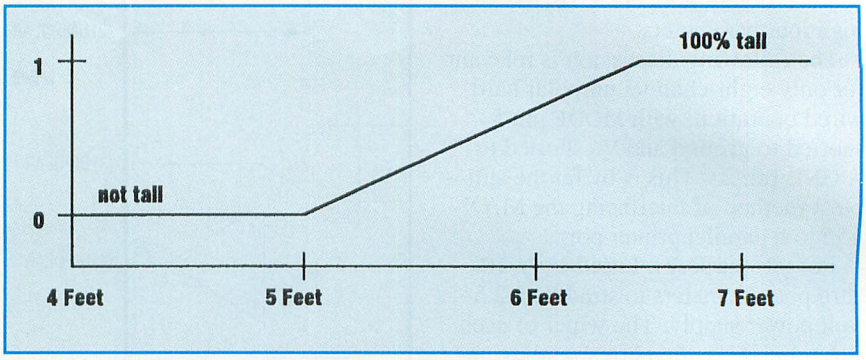


Fig. 1. A sample fuzzy-logic mapping graph.

Together, these two laws define the bivalent logic that nearly everyone learns in school, either formally or informally. The problem is that bivalent logic and natural language rarely coincide. Take, for example, the statement "Helen is tall." In classic logic, this statement has meaning only if "tall" is precisely defined. So give "tall" a specific definition, perhaps 5'10" or taller. If Helen is 5'10.1" tall, she certainly fits the definition. But how about Judy, who is 5'9.9" tall. She misses formal inclusion in the "tall-woman" class by 1/10 inch.

Helen and Judy's heights differ by less than 1/4", and yet one is "tall" and the other is "not tall." To a classic logician, this makes perfect sense, but to most of us, it doesn't.

The contribution of fuzzy logic is to measure the degree of membership in a class instead of splitting hairs over inclusion or exclusion. Helen's inclusion in the "tall-woman" class might be represented by 0.70 and Judy's by 0.68, for example. A woman who is 4'8" tall might have an inclusion value of 0.0 and one who is 6'10" tall would probably be assigned a value of 1.0. This is the principal difference between classic and fuzzy logic. Following the Law of the Excluded Middle, classic logic assigns a true or false value (1 or 0) to every assertion. Fuzzy logic, on the other hand, assigns values of 1, 0 or any real number between these two extremes.

To assign a value, fuzzy logic often uses a mapping function that can be represented numerically or graphically (see Fig. 1). Then any new data can be assigned inclusion values simply by applying the mapping function.

Logical Operations

Of course, logic is concerned with more than simply making and testing assertions. Its real power comes from the operations that can be performed on these assertions. Both classic and fuzzy logic use the same operations: NOT, AND, OR, etc.

Although some disagreement in the fuzzy research community exists regarding exactly how to implement these logical operators, NOT A (if A is an inclusion value) is usually defined as 1.0 - A. If Helen's inclusion in "tall women" is 0.70, her inclusion in "NOT tall women" is 0.30. AND of a pair of fuzzy values is normally calculated as the minimum and OR as the maximum of these values. For example, if Bob's inclusion in "smart men" is 0.9 and his inclusion in "tall men" is 0.8, his inclusion in the set of "smart AND tall men" is 0.8 and his inclusion in the set of "smart OR tall men" is 0.9.

Some researchers have argued that fuzzy logic is the same as probability. But there's a difference between stating that "the probability that Bob is tall is 0.9" and "Bob is very tall" (if an inclusion value of 0.9 is assumed to represent "very"). Also, probability calculates AND and OR in ways that are counter-intuitive for fuzzy operations. For independent events, AND is calculated as multiplication (the odds that Bob is "smart and tall" is 0.9*0.8 = 0.72) and OR is calculated as A+B-A*B (the odds that Bob is "smart OR tall" is 0.98).

It's important to understand that fuzzy logic is a rigorous logic of fuzzy values. Once a membership or inclusion value has been assigned, all of fuzzy-logic's operations are precise mathematical steps. What distinguishes fuzzy logic from classical logic is its ability to work with the "fuzzy" shades between complete truth (1.0) and complete falsehood (0.0).

Fuzzy Control

Fuzzy logic is a multi-valued extension of classic logic. When it was invented by Lotfi Zadeh, now a professor at U.C. Berkeley, in 1964, it was, at first, simply an intellectual curiosity. Zadeh initially suggested that fuzzy logic would be most useful in psychology, philosophy and the human-oriented sciences, in part because it can represent the meanings of everyday speech. Later, however, he showed how fuzzy logic could be used to control complex systems.

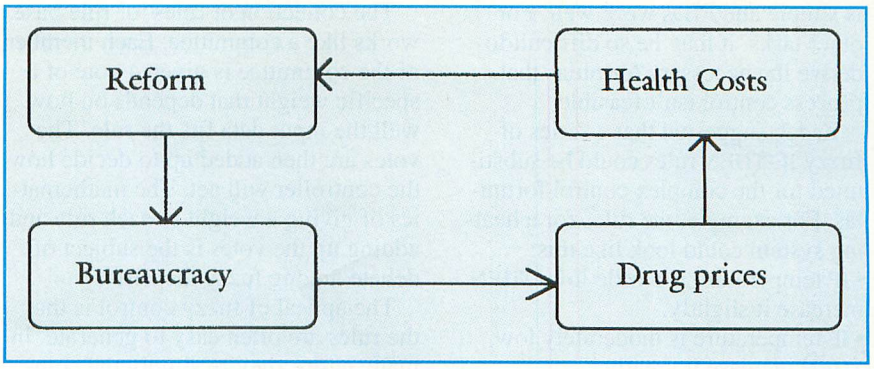


Fig. 2. A simple fuzzy cognitive map, adapted from "Fuzzy Cognitive Maps Model Social Systems" by Rod Taber in *AI Expert* magazine, July 1994.

System control is based on sensors or input devices, actuators or output devices and a target. For example, the target of a heating system is the setting on the thermostat. The sensor is the built-in thermometer, and the actuator is the furnace or fan switch that the thermostat controller can turn on and off. The controller uses the sensors and internal "knowledge" about the system to manipulate the actuators.

Traditionally, engineers use formulas and PID (proportional-integral-derivative) controllers for complex systems. Whether a controller can be developed for a system depends on whether the necessary formulas can be found. For some tasks, the formula

is simple and PIDs work well. For other tasks, it may be so difficult to derive the necessary formulas that process control isn't feasible.

Zadeh suggested that a series of fuzzy IF-THEN rules could be substituted for the complex control formulas. For example, the rules for a heating system could look like this:

- IF temperature is a little low, THEN increase it slightly.
- IF temperature is moderately low, THEN increase it greatly.
- IF temperature is very low, THEN increase it very greatly.

A system based on fuzzy control would read its sensors (in this case, a thermometer of some sort) and send the input value to every rule. Each rule then determines to what extent the input fits into the fuzzy set in the IF clauses. To what extent is the current temperature "a little low," for example. The rule combines the inclusion value (which is between 0 and 1) times its output (for example, 0.8—"increase it slightly") and sends the result to the controller. The controller combines the information from each rule to determine how it should adjust the actuator.

The collection of rules, or rule base, works like a committee. Each member of the committee is given a vote of a specific weight that depends on how well the input data fits the rule. The votes are then added up to decide how the controller will act. The mathematics of giving a weight to each rule and adding up the votes is the subject of debate among fuzzy theorists.

The appeal of fuzzy control is that the rules are often easy to generate. In many cases, they're simply the common-sense knowledge that a human operator develops from experience. And, unlike the PID formulas that may take months or years to develop, a set of fuzzy rules can usually be generated and fine-tuned very quickly.

A number of pioneering fuzzy control applications appeared in the early 1970s. In general, they outperformed human operators and were slightly better than conventional controllers. The first commercial fuzzy system, which appeared in the late 1970s, ran a cement kiln in Denmark. Today, fuzzy control is used commercially for the subway system in Sendai, Japan and for a flock of such appliances as washing machines, microwave ovens, cameras and camcorders and even automobile transmissions.

If you have a fuzzy washing machine, you simply drop in the clothes and push the START button. The fuzzy microcontroller in the washing machine adjusts the wash cycle to fit the clothes and the amount and kind of dirt that's on them. The fuzzy controller gets information about the kind of fabric and the size of the load, about the amount of dirt in the wash water, the water level and the detergent level. It uses 30 or 40 rules to adjust the water and detergent levels, to set the length of each cycle and to determine whether it should repeat a cycle. Because of their sensor and rule base, fuzzy washing machines cause less damage to clothes and rarely under- or over-wash them. They also tend to use less water, detergent and electricity than conventional washing machines.

Fuzzy and Neural

The one real difficulty in developing a fuzzy system is creating and tuning the rules. For some systems, the programmer's intuitions may be suffi-

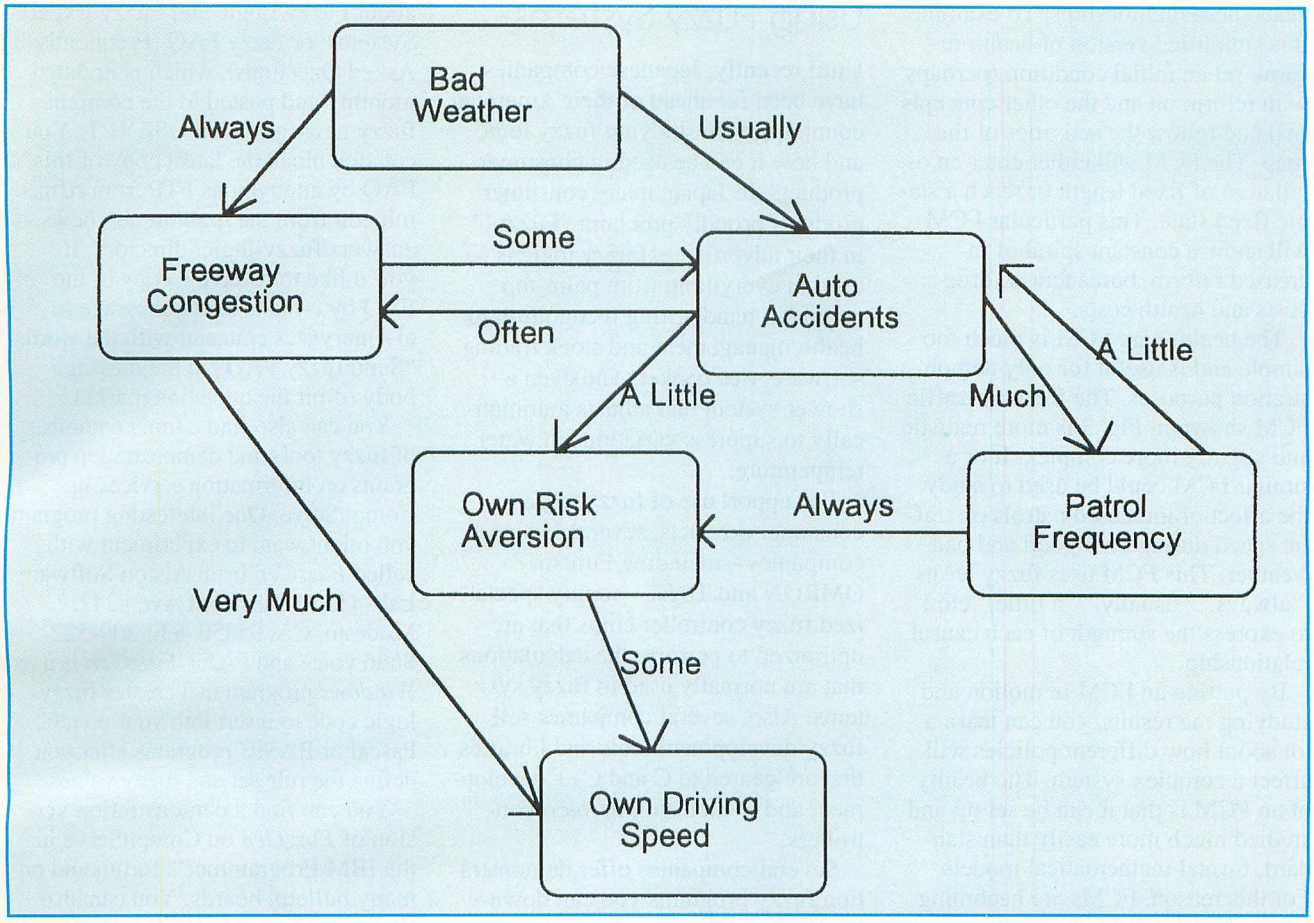


Fig. 3. A more-complex fuzzy cognitive map, adapted from *Fuzzy Thinking* by Bart Kosko (Hyperion, 1993).

cient to at least create a set of rules from which to start. The rules and fuzzy values can then be tuned by trial and error during testing of the controller. But for other systems, it may not be possible to even guess what form the rules should take.

As an example of the above, if you want to create a control system to back a truck and trailer into a parking space, how would you define the rules that are necessary to accomplish this task? At what points in the process would you turn the wheel and by how much? When would you pull forward to get a better angle for backing up? Yet, such tasks are important for many robotic applications.

One of the promising computer technologies of the late 1980s was neural networks, which are sets of hardware or software "neurons" that can learn during a training process. There was a great deal of discussion about neural networks, but by themselves they proved to be too limited and awkward to find many applications. They're often suggested for pattern-recognition problems, but the care needed to create the necessary training materials often outweighs the advantages of using a neural network for a particular task.

Their ability to learn patterns, however, makes neural networks particularly useful for creating and tuning fuzzy rules. In fact, coupling neural networks and fuzzy systems leads to systems that often have more power than either one by itself. For control applications, a neural network is usually set up to watch a human expert perform a task. The network learns from the human expert and translates what it finds into rules for the fuzzy system.

If the fuzzy system's goals can be simulated clearly enough, a neural network can also be used in a feedback loop. The network can watch the success and failure of the rules it creates. The neural network or the programmer guesses at some preliminary rules and then watches the success or failure of those rules when they're used by the fuzzy system. In time, and often very quickly, the neural network and fuzzy system work together to create a finely-tuned rule set.

In most cases, what the neural network "learns" is used to create a fuzzy rule set. Often, the neural network is discarded when the fuzzy controller and rule set are embedded in an application, appliance or complex controller.

Fuzzy Maps

One of the most-interesting applications of fuzzy logic is in a tool called a fuzzy cognitive map, or FCM. By creating an FCM and examining its behavior, researches can study complex feedback systems.

To start with a simple example, suppose an expert predicts that:

(1) Drug prices lead to increased health costs;

(2) Health costs lead to health care reform;

(3) Reform leads to an increased bureaucracy;

(4) Bureaucracy leads to increased drug costs.

Figure 2 shows an FCM that repre-

sents these relationships. To examine this simplified version of health reform, set an initial condition (perhaps with reform on and the other concepts off) and follow the activities of the map. The FCM will either enter an oscillation of fixed length or reach a stable fixed state. This particular FCM will show a constant spiral of increased reform, bureaucracy, drug costs and health costs.

The health-care FCM is much too simple and is useful for only demonstration purposes. The freeway traffic FCM shown in Fig. 3 is more realistic and slightly more complex. It or a similar FCM could be used to study the effect of increased patrols on traffic speed during both good and bad weather. This FCM uses fuzzy terms ("always," "usually," "a little," etc.) to express the strength of each causal relationship.

By putting an FCM in motion and studying the results, you can learn a lot about how different policies will affect a complex system. The beauty of an FCM is that it can be set up and studied much more easily than standard, formal mathematical models. For this reason, FCMs are becoming increasingly popular in the social sciences, virtual-reality experiments, and other areas that deal with complex feedback systems.

Using Fuzzy Systems

Until recently, Japanese companies have been far ahead of their American counterparts in studying fuzzy logic and how it can be used in consumer products. In Japan, many consumer products proudly proclaim "Fuzzy!" in their advertising. Fuzzy logic is used in everything from palm-top computer handwriting recognition to health management and stock trading software, rice cookers and even a shower system that adjusts automatically to suppress variations in water temperature.

To support use of fuzzy logic in consumer products, several Japanese companies—including Fujitsu, OMRON and Togai—supply specialized fuzzy controller chips that are optimized to perform the calculations that are normally used in fuzzy systems. Also, several companies sell fuzzy development tools and libraries that are geared to C and C++ development and to inclusion in microcontrollers.

Several companies offer demonstration fuzzy programs you can download, especially if you have access to the Internet. The best place to start a search for fuzzy products is a document called Answers to Questions about Fuzzy Logic and Fuzzy Expert Systems, or fuzzy FAQ (Frequently Asked Questions), which is updated monthly and posted to the comp.ai.-fuzzy news group on USENET. You can download the latest copy of this FAQ by anonymous FTP from rtfm.-mit.edu from the /pub/usenet /news.-answers/fuzzy-logic/ directory. If you'd like to receive a copy of the FAQ by e-mail, send a message to ai+query@cs.cmu.edu with the words "Send fuzzy FAQ" in the message body (omit the quotation marks).

You can also find a limited number of fuzzy tools and demonstration programs on information services like CompuServe. One interesting program you might want to experiment with is called *FuzzGen* from Alston Software Labs (1320 Standford Ave #242, Modesto, CA, 95350, tel.: 209-522-8666 voice and FAX). *FuzzGen* is a *Windows* program that creates fuzzy-logic code to insert into your own C, Pascal or BASIC programs after you define the rule set and fuzzy values.

You can find a demonstration version of *FuzzGen* on CompuServe in the IBM Programmer's forum and on many bulletin boards. You can also find a number of fuzzy-based programs that play games or perform mundane operations like searching files for text strings.

There are only a few non-technical books about fuzzy logic. The easiest to find is *Fuzzy Thinking, The New Science of Fuzzy Logic* by Brian Kosko (Hyperion, 1993). Kosko is one of the leading proponents of fuzzy logic in the United States, and his book is about equal parts of information and self-congratulation. A second book, *Fuzzy Logic* by Daniel McNeill and Paul Freiberger (Touchstone, 1993), is a good history of the development of fuzzy logic and some of the key ideas. Both books (as well as the USENET FAQ) have bibliographies that will lead you to more technical material.

Whether you're designing control systems or building your own applications, or you're just interested in this emerging technology, you owe it to yourself to investigate fuzzy logic. It's appearing in more and more products from software to appliances as its utility and ease of development become known. If you don't already have a fuzzy product in your home or computer, you will soon. Bank on it.

By TJ Byers

Video Monitors: The Big Picture

In the market for a new video monitor and don't know which way to look? Or do you just want to know what makes them tick? Here's the scoop on both.

Despite the fact that the video monitor is the most-used computer component in our systems, most of us tend to treat it like a second-class citizen—well below the status given to a fast 486DX4-66 or Pentium processor. If this sounds like an accurate description of your attitude, you need to do some rethinking.

No matter how fast your PC runs or how clever your software, the only thing between you and it is a video monitor—your looking glass to the PC world. Your monitor reflects every move you and your PC make. In fact, without a monitor, it would be virtually impossible to use your computer—which is why it shouldn't come as a shock that the computer and monitor must be matched to each other. A change in one often forces a change in the other.

Whether you're in the market for a new video monitor or you're thinking about upgrading your motherboard, you have to know how the two interact and the limitations each imposes on the other. For this, you need a crash course in Video Displays 101 and 102. Here's where this article comes into play.

Monitor Mechanics

At the heart of any desktop video monitor is a cathode ray tube (CRT), which is a large glass bulb shaped like a floodlight, except that it has squared corners. The CRT, often called a picture tube, is a versatile device that's used as a display for many electronic products, including oscilloscopes, radar systems and TV receivers.

Located inside the neck of the CRT is an electron gun that emits a pencil-thin beam of electrons aimed at the screen, which is coated with a phosphorus material. When the electron beam strikes the phosphor, it glows. The number and speed of the electrons striking the screen—called the beam current—determines the brightness of the dot. Color monitors have three electron guns that excite three different colored phosphors of red, green and blue.

Stretched across the face of the screen is a shadow mask that consists of a thin sheet of metal, usually an Invar alloy composite, that's perforated with thousands of very tiny holes in a regular pattern. The electron guns, shadow mask and screen phosphors are accurately aligned in such a way as to form a tight cluster of red, green and blue dots called a triad. Each electron gun is assigned just one color. One gun is responsible for red, another for green and the third for blue.

Because the triad is very small, the colors meld together to create shades and hues. The actual triad dots are invisible except to magnifying-glass inspection. When all three colors of a triad are excited equally, they look like a single white dot. Shades and hues are produced by lowering the beam current of one or more of the electron guns. For example, yellow is a blend of red and green with no blue component. (In case you artists are confused, this is additive blending, not subtractive blending common to paints, where yellow is one of the three primary colors.)

The distance from one dot to its

nearest neighbor of the same color is called the dot pitch. Most monitors have a dot pitch that falls somewhere between 0.25 and 0.31 mm. As a rule, the smaller the dot pitch, the sharper the image. On a 17" monitor, a 0.25-mm dot pitch equals about 100 dots per inch (dpi), which is one-third the resolution you get from a laser printer, while 0.31-mm dot pitch is about 80 dpi—dot matrix quality.

• **Painting the Picture.** A CRT paints pictures on the screen by sweeping the electron beam across the face of the tube in a *raster* pattern. The beam starts from the upper-left corner and sweeps across the face of the tube to the right. Beam current is then turned off and the beam is returned to the left side of the screen just a notch below the first scan line. This process repeats all the way down the screen. In fact, the process is repeated many times before the beam hits the lower-right corner, whereupon, the deflection circuitry returns it to the upper-left corner for another raster scan.

As the beam sweeps across the face of the CRT, the red, green and blue beam currents are modulated to create a mosaic of color dots—called pixels—that generate the screen image.

There are two types of raster patterns: interlaced and noninterlaced. An interlaced display creates an image in two passes by first scanning only the even lines and then painting a second screen of only odd lines. This method is less demanding on the monitor's electronics, but it works well for only moving objects, where the screen is constantly changing—like on your home TV screen. For most computer work, you need a noninterlaced raster, where the scan lines follow one after the other in order.

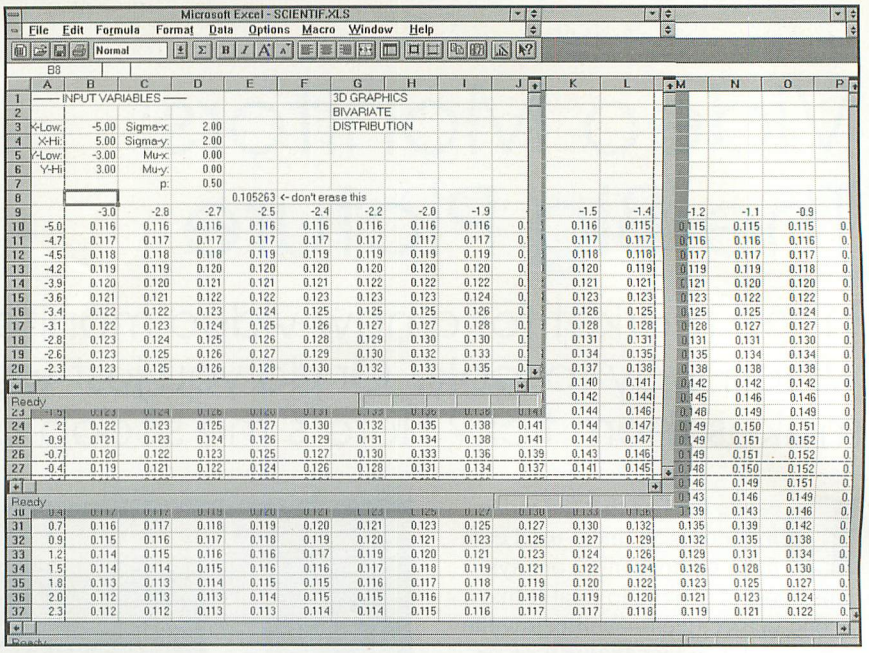


Fig. 1. Screen size affects usable work area and readability of an application. Here's same worksheet at three resolutions: VGA (640 x 480), 800 x 600 and 1,024 x 768. Screen fonts that are 1/8" tall on a 12" monitor grow to 5/32" on a 15" screen and become almost 3/16" on a 17" screen.

The detail of the image is determined by the number of pixels that make up the picture. A VGA controller uses 640 pixels horizontally and 480 pixels vertically to get the message across. SuperVGA screens commonly display higher-resolution images of 800 X 600, 1,024 X 768, 1,280 X 1,024, or 1,600 X 1,024 for a larger picture and greater detail (Fig. 1).

• **Multiscan.** Not all video monitors are capable of displaying the entire range of resolutions. For example, most low-cost monitors have their screens permanently set at VGA's resolution of 640 X 480. By comparison, your TV receiver also uses a fixed-resolution (often called fixed-frequency) display, where every image is composed of 525 vertical lines, regardless of what channel or VCR movie you're viewing. Screen resolution is forever carved in stone and can't be changed.

To display images with resolutions of 800 X 600 and greater, you need a multiscan or multisync monitor. Un-

Table 1. Horizontal Scan Rate Determines Maximum Possible Resolution and Top Refresh Rate*

Resolution	Refresh Rate	Horizontal Scan Frequency	Video Bandwidth
640 x 480	60 Hz	31.5 kHz	25 MHz
640 x 480	70 Hz	38 kHz	30 MHz
640 x 480	72 Hz	39.4 kHz	31 MHz
800 x 600	60 Hz	38 kHz	40 MHz
800 x 600	70 Hz	45 kHz	48 MHz
800 x 600	72 Hz	48 kHz	50 MHz
1,024 x 768	60 Hz	48 kHz	65 MHz
1,024 x 768	70 Hz	57 kHz	77 MHz
1,024 x 768	72 Hz	60 kHz	80 MHz
1,280 x 1,024	60 Hz	64 kHz	110 MHz
1,280 x 1,024	70 Hz	74.5 kHz	125 MHz
1,280 x 1,024	72 Hz	76 kHz	135 MHz

*For ergonomic reasons, typically eye comfort and fatigue, VESA recommends refresh rates of 72 Hz or better, while setting the minimum threshold at 70 Hz. Monitors that support video bandwidths beyond 100 MHz use BNC connectors for input, required for a crisp image at top resolutions.

Buying Smart

When buying a new video monitor, there are a lot of factors to consider. For example, if you use a 14" or 15" monitor to run powerful *Windows* spreadsheets, word processors and CAD drawing programs, you're working with blinders on. Here's how to shop for a monitor that meets your needs.

Price, of course, is a major influence because not every one has deep pockets. Even if you do, you surely want to get the best bang for your buck. Fortunately, monitor prices have dropped a lot in the last few years. The same 15" monitor that cost $800 two years ago now has a street price of just $500, and 14" monitor prices typically range from $200 to $300.

There's more to screen size than meets the eye. The best way to determine the best monitor for you is to examine your work habits. If you do most of your work in DOS on a VGA screen, a 14" monitor is perfectly acceptable—and easy on the pocketbook. But a 14" monitor just doesn't cut it for today's *Windows* software. For any *Windows* application, the least you should consider is a 15" monitor. Street prices normally range from $400 to $600, with a few premium models, such as the NEC 4FGe, going for about $800. For serious *Windows* work, though, a 17" screen is the monitor of choice. Once a very expensive luxury, these beauties now go for less than $1,000, with a few dipping as low as $600.

If you're deep into desktop publishing or CAD, you'll find the extra viewing area provided by a 20" or 21" screen a welcome relief. But don't expect any bargains here. Prices range from $1,600 to well over $3,000.

When buying a large-screen monitor, you must also consider dimensions and weight. A number of Fortune 1,000 companies have a size and weight restriction on monitors, usually because there's only so much space in a standard cubicle. Even when you're buying for home use, some restrictions apply—unless you plan on evicting your wife and kids to make room for a 26" monitor. If the monitor is to sit on your PC, make sure your PC can handle the weight. Many small-footprint PCs can't bear the load of a 50-pound, 17" behemoth.

The largest screen in the world can't make up for bad focus or poor color convergence. Image quality is a complex combination of factors that include small dot pitch, screen treatment and a lot more. Generally, the smaller the dot pitch, the crisper the image. On a 17" monitor, dot pitch should be no greater than 0.31 mm, with 0.28 mm more desirable. Also remember that, as screen resolution increases, dot pitch plays a greater role in image clarity and focus. If you have the opportunity, compare several different makes and models before smacking down your greenbacks.

Screen controls and the power switch should be accessible from the front of the monitor. While on-screen adjustments and digital pushbuttons are preferable, there's nothing wrong with knobs or thumbwheels. The important consideration here is whether or not the monitor incorporates a programmable microprocessor that analyzes and remembers size and centering adjustments.

Unlike such other computer components as disk drives, video monitors are more susceptible to minor variations in production. The components are very sensitive and are easily affected by rough handling. Things like color convergence are easily disturbed by jarring and short falls—even if the drop is less than a foot, which isn't considered a fall by some shipping companies. This is why you should insist on a long warranty (up to three years), plus a money-back guarantee with no restocking charges (which can be as much as 20% of the cost), especially if you're buying via mail order.

Finally, if you plan on sharing your monitor with a Macintosh computer, make sure you select one that is true multiscan and has sync-on-green capability (required by Macs). Also, make sure that you have the correct connectors for both systems. Many high-end monitors use coaxial BNC connectors for separate red, green, blue and sync signals, and the pinouts for the PC and Mac are a lot different.

like fixed-frequency monitors, multiscan monitors have circuitry that can adjust the horizontal and vertical sweeps to match those of different video modes. Sometimes, the sweeps are set at specific screen resolutions, where the screen locks in at defined resolutions, like 640 X 480 and 1,024 X 768. The monitor in this particular example can't support 800 X 600 or 1,280 X 1,024 screens. These monitors are more expensive than fixed-frequency ones but less expensive than true multiscan monitors.

A true multiscan monitor uses variable-frequency oscillators that are controlled by a phase-locked loop (PLL) to synchronize the horizontal and vertical sweep frequencies with those of the video mode—regardless of resolution. As a rule, the greater the resolution, the greater the frequency of the horizontal and vertical sweep oscillators. Exact frequency of these oscillators for any video mode is determined by both screen resolution and refresh rate.

• **Refresh Rate.** The amount of time it takes to paint a screen image is directly proportional to the number of pixels there are in the image. Obviously, it takes longer to lay down 1,024 lines of information than it does 480 lines. The problem here is that the phosphors glow for only a very short time after being excited by the electron beam and fade away rather quickly. When the color dots fade to black before the electron beam returns to reactivate them, the screen flickers like an old-time nickelodeon. The answer, of course, is to repaint the screen more often—which is expressed as the refresh rate.

A faster refresh rate translates into a steadier image and less eye fatigue. Until a few years ago, 60 screen updates per second (60 Hz) was considered acceptable. However, while a 60-Hz flicker is almost imperceptible, after long hours of staring at a monitor your eyes, if not your whole body, feel the effects. For this reason, VESA recommends refresh rates of 72 Hz or better, while setting the minimum threshold at 70 Hz.

Both screen resolution and refresh rate depend on the speed at which the electron beam scoots across the screen. Obviously, to repaint a 1,024 X 768 screen 70 times a second, left-to-right movement must be a lot faster than when drawing a 640 X 480 screen

at 70 Hz. The upper limit of this motion is determined by the horizontal scan rate. While the required horizontal scan rate for any given resolution and refresh rate can be calculated using the formula: Horizontal Scan Rate ≅ 1.04 (Vertical Resolution X Refresh Rate), I prefer to use the chart in Table 1, and, I suspect, so will you.

Video bandwidth (also listed in Table 1) is calculated using the formula: Video Bandwidth = 1.4(horizontal resolution X vertical resolution X refresh rate).

Neither formula is perfect because the multiplier factor (1.04 in the first formula and 1.4 in the second) is an estimate that takes into account the retrace times, which vary according to screen resolution.

The vertical scan rate sets the upper limit for the number of screen refreshes per second. It must equal or exceed the refresh rate. For example, you can't force 126 screen refreshes per second from a monitor that has a vertical scan rate that tops out at 80 Hz.

• **Microprocessor Control.** A problem with multiscan monitors is screen sizing. As the video modes shift from graphics to text, which is what occurs when you click on the MS-DOS Prompt icon in *Windows*, the screen changes size and shape. For example, VGA text measures 640 X 400 while VGA displays graphics in 640 X 480 format. Since this is typical of all video modes, you can see the problem. Unless the monitor has some method of correcting for changing screens, you'll find yourself constantly reaching for the sizing controls.

About half of all 15" monitors and most monitors with a screen size of 17" and larger have an internal microprocessor that remembers the proper screen settings for several different video modes. Generally, the monitor provides text and graphics presets for the most-popular screen resolutions of 640 X 480 through 1,024 X 768, plus a handful of memory for storing user-defined screen preferences. Knowing how user adjustments can sometimes get out of hand, most large-screen monitors also have a reset button that returns the display to the factory settings should your adjustment antics land you in the twilight zone.

• **Screen Controls.** Fine-tuning the image on the screen has come a long way since the first color monitors,

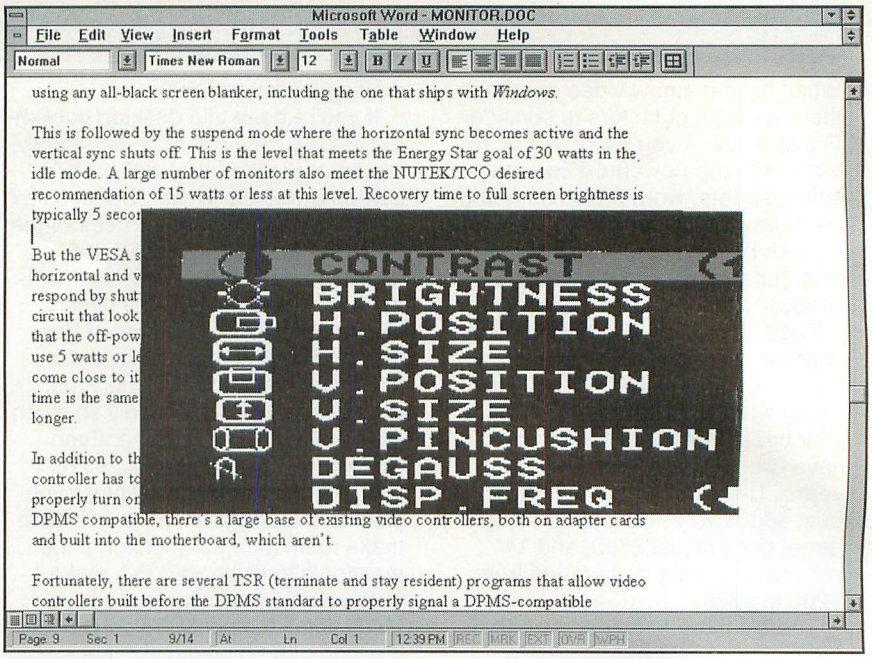


Fig. 2. On-screen controls, like these from a ViewSonic 17G monitor, greatly simplify screen adjustments.

which had nothing more than brightness and contrast knobs. Today's large-screen monitors often have controls that let you adjust complex parameters, like the tilt of the image or color convergence, just to mention two. And many monitors have replaced the old twist knobs and thumbwheels with digital controls. The new twist is monitors with an on-screen display of functions that greatly simplifies the adjustment process, like those from Acer and ViewSonic (see Fig. 2).

The upshot of the foregoing is that a monitor with a poor display no longer needs to be returned for service because *you* can now fix many problems using the new controls. For those few fixes you can't do yourself, several large-screen monitors have a dedicated service port that lets a field technician tweak internal adjustments without ever removing the cover, which literally takes a big load off you and your back because you don't have to schlep a 50-pound monitor to a service depot for repair.

• **Screen Brightness.** While shadow-mask CRTs account for 97% of the video monitors sold today, they have a rather distinctive shortcoming—lack of brightness. The problem is that few electrons ever make it through the tiny holes. Most are absorbed or deflected, which means that the screen isn't as bright as it could be. To increase screen brightness, Sony invented the Trinitron, which uses a shadow mask made of many very thin wires that are strung between a top and bottom support.

Another difference is that the color triad is laid down in stripes, rather than dots. As a result, the triad is made up of rectangles that actually butt up against each other, as would be the case of crossing a border when traveling from one state to the other, as opposed to having an island (color dot) with a whole lot of water (wasted screen area) surrounding it, for a 25% increase in active phosphor area and proportional screen brightness (Fig. 3). Instead of using the term "dot pitch," the distance between stripes of the same color is call aperture grill. For all intents and purposes, it means the same thing as dot pitch.

Because the vertical wires are long and thin, they vibrate like a guitar string when struck by the electrons. To damp the vibrations, the Trinitron tube weaves two rather large wires through the array about one-third of the way from the top and bottom of the screen. In fact, these wires are clearly visible as two fine lines on an all-white screen.

Mitsubishi also makes a Trinitron-like CRT that uses a stripe shadow mask and damping wires. To get

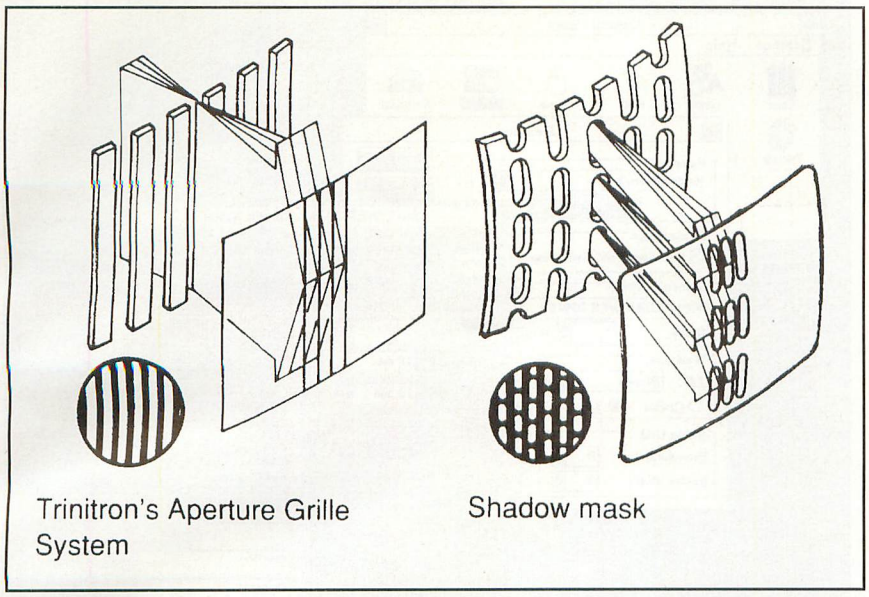


Fig. 3. Sony's Trinitron aperture grille with long and unbroken slits delivers more color and brightness to screen. Mitsubishi also makes a Trinitron-like CRT that uses a stripe shadow mask.

around Sony's patent license, Mitsubishi uses three electron guns that are placed side-by-side in a straight line, which they call in-line, rather than use the one-gun, three-beam system of the Trinitron.

Zenith Data Systems (ZDS) takes a different tack to increase screen brightness. As stated, screen brightness depends on beam current. The stronger the current, the brighter the phosphor glows. Unfortunately, the greater beam current also means more electrons are absorbed by the shadow mask, which translates into heat. As the shadow mask gets hotter, it expands and causes the alignment holes to shift position, a condition known as "doming." The result is color impurity where the green bleeds onto the red, and so forth.

ZDS solves the problem by stretching the shadow mask extremely tight —like a drum skin—and securing it with pegs instead of springs. Because the shadow mask is highly stressed, it can withstand much greater beam currents before it distorts—100% more, to be exact, for a 50% brighter screen.

Picture Window to the World

Regardless of what goes on inside the CRT, it's what you see that really counts. A lot of what you see is dictated by the size, shape and treatment of the tube.

Monitor size, like in TV receivers, is measured by the diagonal size of the picture tube *before* it's mounted in the cabinet. Subtract for the plastic bezel, and you end up with a screen that's always smaller than advertised. Typically a 15" screen actually measures 13 1/2" diagonally.

Screen size is important because, as you increase the resolution of the screen, you see more of your spreadsheet or document, which means the numbers and letters get smaller. A capital "I," for instance; is 10 dots tall and measures 1/8" on a standard 14" VGA monitor. If you double the resolution without changing screen size, the dots end up twice as close together, and a 10-dot "I" will shrink to 1/16". However, if you paint the same "I" on a larger screen, it grows proportionally larger, the way letters on a balloon expand as you blow air into it. Screen fonts that are a mere 1/8" tall (0.125") on a 12" monitor grow to 5/32" (0.156") on a 15" screen and become almost 3/16" (0.187") on a 17" monitor.

The shape of the screen is also largely determined by screen size. All picture tubes smaller than 15", and many 16", have a screen with a spherical shape that looks like it's cut from a beach ball, as do most TV screens. CRTs with a spherical face are cheaper to manufacturer and require less-expensive electronics to steer the electron beam.

Flat-square screens, which are used in the majority of monitors of 15" and larger, are neither flat nor square, but they're flatter than conventional CRTs because the curvature of the screen looks like it's cut from a larger beach ball.

Vertically flat screens are flat along the vertical axis but curved horizontally, as would be the case if you took an outside slice from a large, round cake. Sony's Trinitron has a vertically flat screen, as does Mitsubishi's DiamondTron tube. The only monitor with a completely flat screen is the CCM series from ZDS. However, using a vertically flat or completely flat screen needs some getting used to because, at first, it looks like you're peering into a tunnel. Thankfully, there's a bright light at the end to the tunnel.

Improving the Image

To improve the clarity of the image, most video monitors have some kind of screen treatment to reduce glare and reflections from overhead lighting. Silica coating is the most popular, but because it's made from a silicon base, which is the same stuff beach sand is made of, it gives the screen a grainy texture that tends to dull the overall display.

A better solution is the anti-reflective (AR) coatings developed by NASA for the Space Shuttle's windshield and other optical devices. These compounds reduce glare and reflections by laying down extremely thin layers of materials that ward off glare, using destructive interference. Simply put, the anti-reflective compound traps a certain wavelength of light and captures it. Because the compounds are wavelength- (color-) sensitive, though, you need several layers of different compounds deposited one atop the other for the coating to be effective.

If you look closely at a quality camera lens, you'll see a purple gleam, which is the mark of a lens that has many layers of AR coating.

Coating a small camera lens with several layers of AR is no big deal; doing the same with a 17" CRT *is* a big—and *expensive*—deal. The shape of the screen often determines the ef-

fectiveness of the treatment. For example, it's easier to coat a flat-square screen than it is to coat a 14" spherical screen. The Trinitron's vertically flat tube is easier yet, and the completely flat ZDS screen is easiest of all. Consequently, several types of treatments are used to maximize the benefit while balancing costs. The most common, of course, is silica, followed by anti-reflection, anti-glare (ARAG), anti-reflection, anti-static (ARAS), and anti-glare, anti-reflective, anti-static (AGRAS).

NEC prefers not to use any type of coating on its monitor screens, rationalizing that the added brightness is more important and that most reflections can be eliminated by proper adjustment of the tilt-swivel stand. Still, the best laid plans of mice and men need a back-up plan, which is why NEC sells an optional $100 snap-on, anti-glare filter for users who find reflections of the uncoated screen objectionable.

Chemical coatings are also used to increase screen contrast. The ZDS CCM-1490 monitor is an excellent example of a CRT that uses an optical coating to give the screen an unprecedented 100:1 contrast ratio. Sony's Trinitron isn't far behind with an 80:1 contrast ratio. This is because both tubes have brightness to spare and can afford to waste a little in favor of higher contrast.

Most CRTs have a 50:1 contrast ratio. By comparison, most notebook computer screens have a 20:1 contrast ratio, and only the best and most-expensive color portables approach the 50:1 mark.

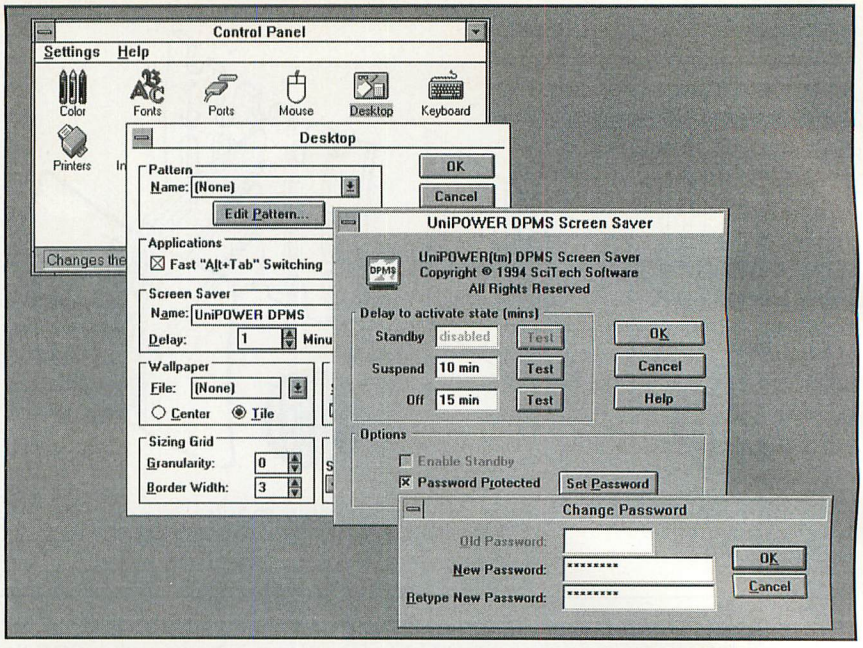


Fig. 4. Special TSR software, like SciTech Software's *UniVBE/Pro* 5.0 shareware, can make an ordinary VGA or SuperVGA video controller behave like an energy-saving DPMS controller.

Color Matching

One of the most-important jobs you'll want your monitor to perform is to help you prepare good-looking presentation graphics. But what you see on the screen isn't necessarily what you get on the printed page or overhead slide, even if you use an expensive top-of-the-line printer or a professional printing company. Nothing is worse than having your ruby reds translate into burgundy when printed.

The fault isn't in the monitor, the color printer or your printing house. The fault, if you can call it such, is in the way the eye perceives colors. Video monitors use the additive-color method, where the three primary colors of red, green and blue are blended together. Color printers, on the other hand, use the subtractive-color method: Dyes or pigments are used to absorb certain colors and reflect others, giving the paint or ink it's characteristic tint. The problem is that the two methods don't always match perfectly, especially when it comes to producing subtle shades and hues.

An increasing number of monitors have color matching that lets you adjust the color balance of the screen image to match those of your printer. For example, if the headline text in your press release has shifted to olive drab from the shamrock shade that looked so compelling on-screen, all you have to do is adjust the *intensity* of the green gun so that the screen headline looks olive, too. Now that you've synchronized the monitor and the printer, use your software presentation package to reset the headline back to shamrock, and that's what you'll get in print.

Another convenient color-matching feature found in some large-screen monitors is preset background temperatures that change the image from pink (tungsten) to neutral (cool-white fluorescent) to a slight blue (daylight) cast for color matching with popular photographic film emulsion temperatures of 5000, 6500 and 9300 K, respectively.

Energy Conservation

An important environmental issue that hits directly home with monitors is energy conservation. This is because your monitor is the most-used component in your system, and it typically draws the most power. For example, a

Table 2. Recommended Power Levels for Energy Star & NUTEK/TCOEenergy-Conservation Proposals.

	Normal	Standby	Suspend	Off
Energy Star	100%	Not defined	<30 watts	Not defined
NUTEK/TCO	100%	< 30 watts; < 15 watts recom	< 8 watts; < 5 watts recommended	< 1 watt

Table 3. VESA's DPMS uses the horizontal and vertical sync signals as the trigger for power-down operation. Standby state is optional and may not be supported by some monitors.

	Normal	Standby	Suspend	Off
H-sync	On	Off	On	Off
V-sync	On	On	Off	Off
Power level	100%	80%	<30 watts	<8 watts
Mitsubishi Diamond Scan 17FS—typical power usage	106 watts	78 watts	10 watts	5 watts

17" monitor can easily draw 100 watts or more of power. While this may not seem like much, it's about twice as much as most desktop computers draw. What's even more appalling about the situation is that there are many monitors that are never turned off during lunches, meetings, phone conversations or after hours. During these times, the screen simply sucks up power for no good reason. A small business with just 15 large-screen monitors running around the clock can consume as much power in one day as many households use in a week!

The answer is a proposal—not a requirement or government mandate—put forth by the Environmental Protection Agency (EPA) called "Energy Star." To garner an Energy Star rating, a monitor must use 30 watts of power or less when idle. Actually, Energy Star is a looser version of the NUTEK/TCO energy-saving proposal put together by a coalition of Sweden's Department of Energy Efficiency (NUTEK) and TCO, a trade union, which ultimately plans to limit the power-off usage to 1 watt (Table 2).

While participation in either program is strictly voluntary, nearly every monitor manufacturer complies with one or both. Moreover, there are no set rules on how to attain these power-saving levels. How it's done is strictly left up to the individual vendor.

There are two methods commonly used to attain the Energy Star and NUTEK/TCO goals. One is the Video Electronics Standards Association (VESA) standard. The other is video blanking signaling.

DPMS

The most-popular is the VESA standard, which uses a four-step program called Display Power Management Signaling (DPMS) to meet—and exceed—Energy Star's guidelines. However, it falls short of complying with NUTEK/TCO recommendations on the low end. DPMS uses the horizontal and vertical sync to send a binary code to the monitor, which decodes the message and shifts the monitor into the appropriate power-saving mode (Table 3).

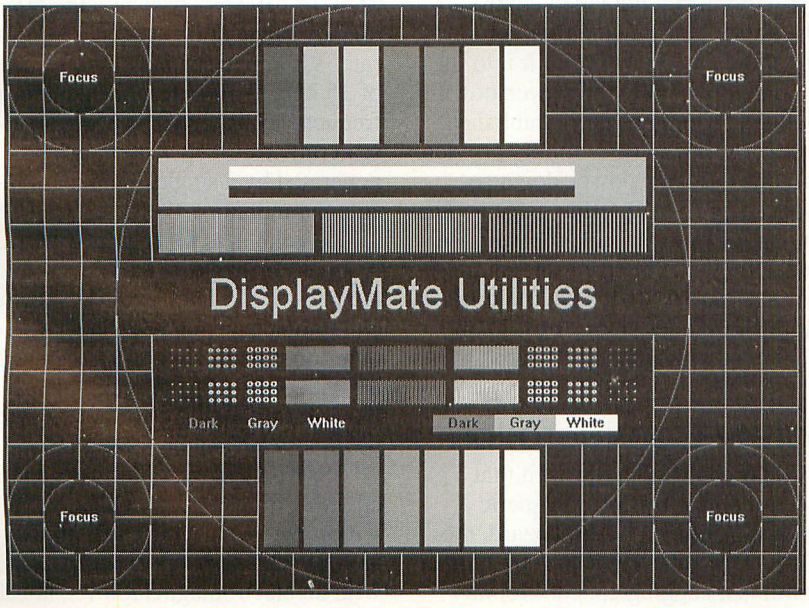
Step one is normal mode, in which the monitor is active and getting both sync signals. The next step is standby and is activated by disabling horizontal sync while maintaining vertical sync. At this level, the power is reduced by a mere 20%. Generally, it's done by turning off the CRT's guns—the same thing you can do yourself by using any all-black screen blanker, including the one that ships with *Windows*.

This is followed by suspend mode, in which horizontal sync becomes active and vertical sync shuts off. This is the level that meets the Energy Star goal of 30 watts in idle mode. A large number of monitors also meet the NUTEK/TCO desired recommendation of 15 watts or less at this level. Recovery time to full screen brightness is typically 5 seconds or less.

But the VESA standard takes it one step further to a fourth level by shutting off both horizontal and vertical sync. This signals the monitor that it's nighttime, and most respond by shut-

Passing the *DisplayMate* Test

How can you tell if your monitor is up to snuff? By using a video diagnostic program like *DisplayMate* from Sonera Technologies (tel.: 800-932-6323), you can. *DisplayMate* is a software package designed for users who want to adjust their monitors for best possible image. Among its battery of benchmarks are intricate geometric patterns, delicately shaded color bars, and grayscales that let you adjust your many controls for optimum image quality.



ting off all circuits—including the tube's filament—except for a watchdog circuit that looks for any sync activity that will awaken the monitor.

DPMS specifies that the off-power consumption be 8 watts maximum, but many DPMS-compliant monitors use 5 watts or less. Very few meet the 1-watt goal targeted by NUTEK/TCO, albeit some come close to it, with wattage ratings between 1 and 2 watts. In off mode, recovery time is the same as it would be from a cold start, which can take up to 20 seconds and longer.

In addition to the monitor being DPMS-aware, so must the video controller. The video controller must be able to interpret instructions from the DPMS software and use them to properly turn on and off the sync signals. While most of today's video controllers are DPMS-compatible, there's a large base of existing video controllers, both on adapter cards and built into the motherboard, that aren't.

Fortunately, there are several TSR (terminate-and-stay-resident) programs that permit video controllers built before the DPMS standard to properly signal a DPMS-compatible monitor (Fig. 4). In fact, several monitors, including ADI and ViewSonic, ship with an excellent DPMS program developed by Optiquest called *Opti-Green* (obviously, *Opti-Green* also ships with Optiquest monitors). These programs work by accessing an unassigned video BIOS call that controls the horizontal sync and vertical sync signals. However, this BIOS call isn't always free for the taking, which means that there are some controllers with which the software won't work. Nonetheless, they boast an impressive 97% compatibility rate.

Video Blanking Signaling

Aware that not all PCs are capable of DPMS signaling, several monitors—including models from Nanao and Sony—opt for the video-blanking signaling method, which triggers off a blank screen created by a screen saver, like the ones in *Windows* and *After Dark*. A blank screen is an all-black screen that has both horizontal and vertical sync signals present but no red, green or blue video information. By itself, a blank screen reduces power usage by 20% to 25% because the electron guns don't have to supply current to the screen.

When a video-blanking monitor detects a blanked screen, it enters the power-saving modes. From this point on, the monitor controls the power-management process without help or instruction from the video controller. The power-down modes are controlled by an EEPROM built into the monitor. Typically, the power-down routine is similar to that established by VESA, but some monitors provide only the two-step power-down sequence suggested by Energy Star. The amount of time the monitor waits before acting on a blanked screen and the time intervals between the different power modes are user-programmable via software.

Safety Consideration

While no one has yet proven that a video monitor's electromagnetic fields constitute a health hazard, the effect of monitor emissions on human health is a nagging concern for anyone who spends long hours staring at a video display. The types of emissions commonly found around display terminals are of two different types: extremely-low frequency (elf) radiation and very-low frequency (vlf) radiation.

Elf emissions fall within the range of 50 to 150 Hz—basically the frequency range of the screen's refresh rate. Vlf emissions have frequencies of 15 kHz to 100 kHz, or the range of frequencies used for the horizontal scan rate. Both types of emissions are generated by a single component inside the monitor—the yoke.

The yoke is a coil of wire—basically an electromagnet—wound around the neck of the CRT to deflect the electron beam from one place to another on the screen, generally in a raster pattern. As the currents through the yoke are modulated to change the beam's speed and direction, elf and vlf electromagnetic fields are generated, most of which are concentrated within the neck of the CRT. But, as anyone who has ever experimented with an electromagnet knows, not all

Screen Adjustments: Magical Mystery Tour

Do you find the plethora of screen adjustments confusing? Here are the screen functions they control and how to use them.

Degauss removes color swirls caused by a change in the earth's magnetic field that sometimes occurs when the monitor is tilted or swiveled during operation. Wait at least 10 minutes between pressings.

Horizontal Position, sometimes called "horizontal phase," moves the image from side to side.

Horizontal Size increases/decreases the width of the image.

Keystone Balance distortion occurs when the image looks like a parallelogram instead of a rectangle. Adjust the control until the corners are square.

Pincushion Balance distortion occurs when one side of the image bows inward and the other side bows outward. Adjust the control until both sides are straight.

Pincushion/Barrel distortion is an equal amount of inward or outward bowing on both sides of the image. Adjust the control until both sides are straight.

Rotate spins the image so that its edges line up parallel with the edges of the bezel.

Screen Temperature refers to the type of film emulsion and lighting associated with photographic images. Commonly supported temperatures are:

9300° K—bluish-white: outdoors

6,500° K—neutral: tungsten lamp or cool fluorescent

5,000° K—ruddy: warm tungsten lamp

Static Convergence distortion is a separation of the white dots into their red, blue and green color components. Distortion is caused by a misalignment in either vertical or horizontal convergence or both. A crosshatch or dot pattern is needed to properly make this adjustment.

Trapezoid/Keystone distortion occurs when image width changes size from top to bottom. Adjust the control until the top and bottom widths are equal.

Vertical Position moves the image up and down.

Vertical Size increases/decreases the height of the image.

the energy is delivered to the core of the electromagnet. A fair amount radiates into space. This is the source of the monitor's emissions.

In 1987, the Swedish Government's Department of Labor (SWEDAC) proposed a standard, called MPR I, with the goal of limiting potentially harmful monitor emissions to a safe level. After deeper inspection, SWEDAC decided to tighten the standard and released the MPR II specification, which is now accepted as a minimum requirement here and abroad. Since that time, the TCO trade-union affiliate proposed a more-rigorous standard, which is still waiting to gain wide acceptance.

There are two ways to reduce monitor emissions. The first, and least-effective, is via a metal shield, usually made from a mu-metal alloy, that encases the monitor. This method is heavy, expensive and difficult to incorporate into a production line. A better method is to change the geometry of the yoke so that most of the energy is concentrated at the core. Using a combination of bifilar winding techniques (two wires in close proximity act like one) and litz wire (wire strands braided around a cotton core), CRT manufacturers have been able to reduce emissions of monitors to MPR II standards without resorting to extraordinary measures.

Even if a monitor meets the MPR II standard, it isn't necessarily "safe." Thankfully, there are things you can do to minimize your exposure and possible risks. The most-important is to understand where the radiation comes from, very little of which emanates from the screen itself. The strongest source of emission is from the back of the monitor, with sides and top emissions having lesser strength. By carefully adjusting the monitor's tilt/swivel base, you can avoid the brunt of most radiation.

Crystal Clear

As you can see, the most-important link between you and your computer is more complex than it looks. By arming yourself with the information presented here, it makes the task of buying a new video monitor less traumatic. And it may prevent a fast-talking salesperson from selling you something you don't want or need. ■

By Jan Axelson

Serial Ports Inside and Out

Part 2

From the Connector Out

In this article, I continue an exploration of possibilities and applications for a personal computer's (or other device's) serial port. The main focus this time out is on the signals, cables and interfaces from the connector out. Since many serial-communications problems are the result of cable and interface problems, understanding this part of the link is important if you're designing or troubleshooting serial connections systems.

Essential RS-232 Facts

Another term for the serial port on a PC is RS-232 port. This refers to the RS-232 standard, which defines three things: the names and functions of the signals in the link, electrical characteristics of those signals and pin assignments and other mechanical aspects of the interface. Understanding the basics of RS-232 can help you put together serial links that work reliably and diagnose problems when they do occur.

Officially, the standard is now called EIA/TIA-232-E. The 36-page document, including an appendix with some applications information on cable design, is available for $47 plus shipping from Global Engineering Documents.

Although the original RS-232 standard designates 25 lines in the interface, you can get by with as few as three, and personal computers rarely use more than nine. The unused signals are intended for use with synchronous modems, secondary transmission channels and selecting a transmission speed on dual-rate modems.

The full interface includes a shield connection (pin 1) to permit grounding of a cable shield, but this connection is absent on many PCs. Earlier versions of the standard called this pin protective ground, and it was sometimes used to electrically connect the chassis or frames of the equipment on both ends. The current version of the standard recommends using a separate wire for this application, if needed.

Much of the RS-232 terminology relates to its origin as a standard for communicating between a computer terminal and a modem. The standard calls the computer end of the link the Data Terminal Equipment, or DTE. It calls the modem end the Data Circuit-terminating Equipment, or DCE. In practice, RS-232 is now used for many things besides terminal-to-modem communications. Most often, you will find a computer of some type at one end of the link, but the other end may connect to a modem or to a second computer (which may be a personal computer, microcontroller or mainframe), or to a mouse, printer or other device with a serial interface.

Table 1 lists the nine most-often used RS-232 signals, along with their designated functions. The essential signals are TD, which carries data from the DTE to the DCE; RD, which carries data from the DCE to the DTE; and SG, which is signal ground. The others are optional control signals intended for communicating information about the readiness of a device or the presence of a ringing or carrier signal on a phone line.

It doesn't matter which device in a link is the DTE and which is the DCE,

Table 1. Most Personal Computers Use Just These Nine of the RS-232 Signals

Popular Abbreviation	RS-232 Designation	Signal Name	Pin DB-25	Number DB-9	Signal Direction	Comments
TD	BA	Transmitted Data	2	3	To DCE	Carries data from DTE to DCE.
RD	BB	Received Data	3	2	From DCE	Carries data from DCE to DTE.
RTS	CA	Request To Send	4	7	To DCE	Tells DCE that DTE has data to send. See CTS.
CTS	CB	Clear To Send	5	8	To DTE	Response to RTS. Tells DTE it's okay to send data.
RI	CE	Ring Indicator	22	9	To DTE	Indicates that ringing voltage is present on telephone line. See DTR.
DTR	CD	Data Terminal Ready	20	4	To DCE	Response to RI. Tells modem to answer phone or signals that DTE is ready to operate. See DSR.
DSR	CC	Data Set (DCE) Ready	6	6	To DTE	Tells computer that DCE is ready to operate.
CD	CF	Carrier Detect	8	1	To DTE.	Indicates that DCE is receiving suitable signal, such as a carrier in expected frequency band.
SG	AB	Signal Ground	7	5	—	Common ground for all signals.

DTE: Data Terminal Equipment. Computer in a computer/modem link. Usually has male connector.
DCE: Data Communications Equipment. Modem in a computer/modem link. Usually has female connector.

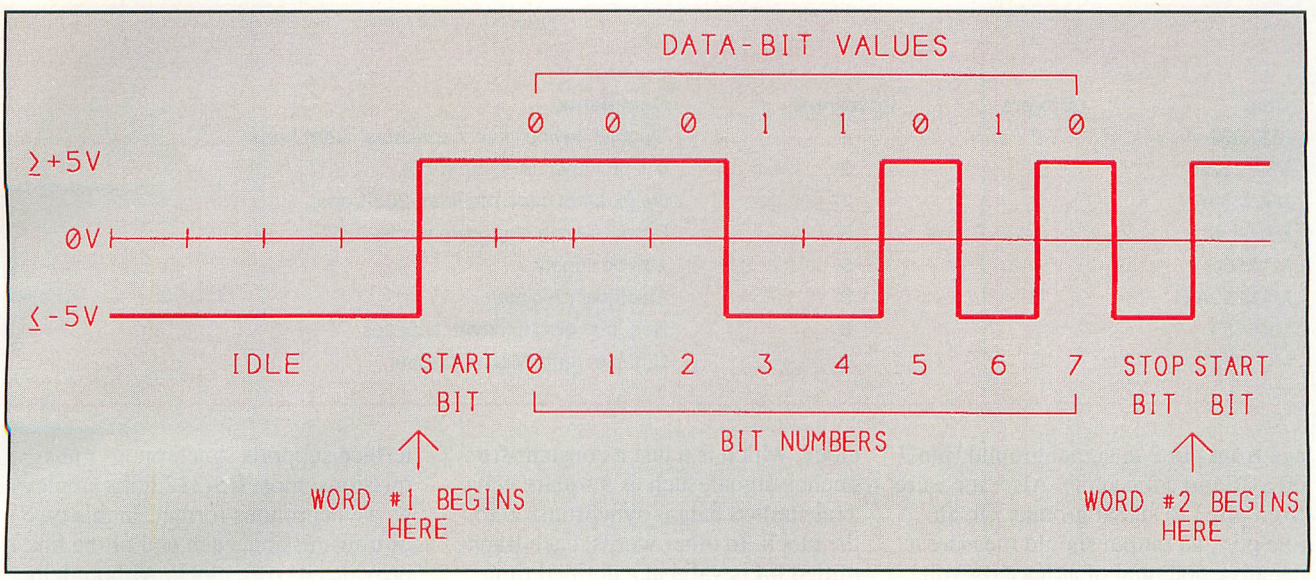


Fig. 1. A typical serial transmission of a byte of information. This example shows the transmission of an "X" (ASCII code 58h) with one start bit, one stop bit and no parity.

but you must have one of each. The names DTE and DCE define the configuration of inputs and outputs at the connector. The signals are named from the perspective of the DTE. For example, TD (transmit data) is an output on a DTE and an input on a DCE, while RD (receive data) is an input on a DTE and an output on a DCE.

The serial ports on most PCs are configured as DTEs. If you cable together two DTEs with an ordinary, straight-across cable, the TD outputs will connect to each other and your data won't go anywhere.

If you need to connect two DTEs or two DCEs, use a null-modem cable or connector that simulates a connection between a DTE and a DCE by swapping the complementary signal and control lines, for example, by connecting each TD to RD on the opposite end. (The name null-modem refers to its origin as a cable that bypasses the computer-to-modem (DTE-to-DCE) connection and directly connects together two computers (DTE-to-DTE).

The latest version of the RS-232 standard specifies what has become a standard configuration by default—that the DTE uses a connector with male, or pin, contacts, and the DCE uses a connector with female, or socket, contacts.

Some serial ports have jumpers that enable you to configure the port as either a DTE or DCE. But since you can't easily change the connector itself, if you configure a male connector as a DCE, you'll probably still need a gender-changing cable or connector with female connectors on both ends.

The connector type recommended by the standard is a 25-pin male D-sub connector, the shell of which is roughly in the shape of an upper-case D. The D shape forces you to orient the connector correctly when you plug it into a port. The contacts are in two staggered rows, with each row 0.109" apart.

When you're connecting an RS-232 cable to a personal computer, be careful not to confuse the parallel port's D-connector with the serial connector. On most PCs, the parallel ports use a female (socket) connector, while 25-pin serial ports use a male (pin) connector.

Some computers use a nonstandard nine-pin D-sub connector that includes only the nine signals detailed in Table 1. This smaller connector leaves more room for other connectors on an expansion card's back panel.

A nine-pin connector has different pin designations, even for the signals on pins 1 through 9. In particular, pins 2 and 3 are reversed, with pin 2 being RD and pin 3 being TD.

Other non-standard connectors you may see are the RJ-11, RJ-12 and RJ-45 phone jacks that are compact and inexpensive solutions for interfaces that have no more than four, six or eight wires.

For use where space is tight, the latest version of the RS-232 standard recommends a different alternative. This connector has 26 contacts that are spaced 0.05" apart in each of two parallel rows and a D-shaped shell. Pin designations are the same as for the 25-pin connector, with pin 26 unused.

If you need to cable together different types of connectors, adapters are widely available, or you can make your own. Dozens of mail-order suppliers sell cables and connectors. B&B Electronics, for example, specializes in serial-port solutions, including cables and connectors.

If you're not sure whether a 25-pin connector is wired as a DTE or DCE, a voltmeter is all you need to identify which of pins 2 and 3 is the data input and which is the data output.

You can make the measurements directly at the port connector or on the connector at the end of the cable, whichever is more convenient. Measure on a port that's powered but idle or not currently in use.

On most connectors, the pin or socket numbers are stamped near the pins or sockets, though you may have to look closely to see them.

On the connector, measure the volt-

Table 2. Popular Chips for Interfacing 5-Volt Logic to RS-232

Chip	Drivers	Receivers	Comments
MAX232	2	2	Original device; 1-µF capacitors, 120K bps.
MAX232A	2	2	0.1-µF capacitors, 200K bps.
MAX233A	2	2	No external caps required, 200K bps.
MAX236	4	3	Power-saving shutdown mode.
MAX560	4	5	+3-volt supply.
MAX252A/B	2	2	Electrically isolated.
MC1488	4	0	Requires bipolar power supplies.
MC1489	0	4	Complements MC1488 driver.

age from pin 2 to signal ground (pin 7 on a 25-pin connector). Also, measure from pin 3 to signal ground. On an idle port, an output should measure a negative potential of at least –5 volts and typically ranges from –7 to –12 volts. An open, or unconnected, input should measure less than +2 volts and is typically close to 0 volt. If pin 2 is negative, you have a DTE. If pin 3 is negative, you have a DCE.

A few computers and other devices that have serial ports require use of some or all of the handshaking, or control, signals in the interface. If this is the case, and if the other end of your link doesn't support the handshaking (in a three-wire interface from a microcontroller, for example), you can often solve the problem by wiring one of the control outputs on the device to its control inputs. On a DTE, you'd connect DTR, CTS, DSR and CD. In this way, whenever the DTE asserts Data Terminal Ready, it will also appear that the DCE is asserting Clear to Send, Data Set Ready and Carrier Detect.

Some serial-port cards have jumpers that permit you to force the control outputs to true. You can do the same thing with software by writing to the appropriate registers in the serial port's UART, as I described last time.

Transmitting Formats

In a serial link, data bits arrive one after another over a single wire. The receiving end must have a timing reference so that it can tell where one bit ends and the next begins. There are two ways to provide this timing reference.

In a synchronous transmission, one end of the link provides a master clock, which is a just a constant-frequency signal, such as a square wave. Transmitted data is synchronized to the clock. In other words, each transmitted bit is valid at a defined time after a clock transition. The receiver uses the clock to determine when to read the incoming bits.

A synchronous interface requires a dedicated line for the clock signal. So a two-way interface typically contains a line for data in each direction, plus a line for the clock and a common ground reference. Synchronous interfaces are popular for short-distance links, such as between components on a single circuit board. The I^2C interface is one example.

Although the complete RS-232 interface supports synchronous transmissions, most RS-232 links employ an asynchronous format. In this type of transmission, each end of the link provides its own clock. Although the clocks must match closely in frequency, an exact match isn't required.

Although the format can vary, a typical transmission sends data in the format of one start bit, followed by eight data bits (beginning with Bit 0, or the least-significant bit), and one stop bit. Shown in Fig. 2 is an example of a typical transmission. Another popular format is one start bit, seven data bits (using ASCII characters 0 through 127, for example), one parity bit for error-checking and one stop bit.

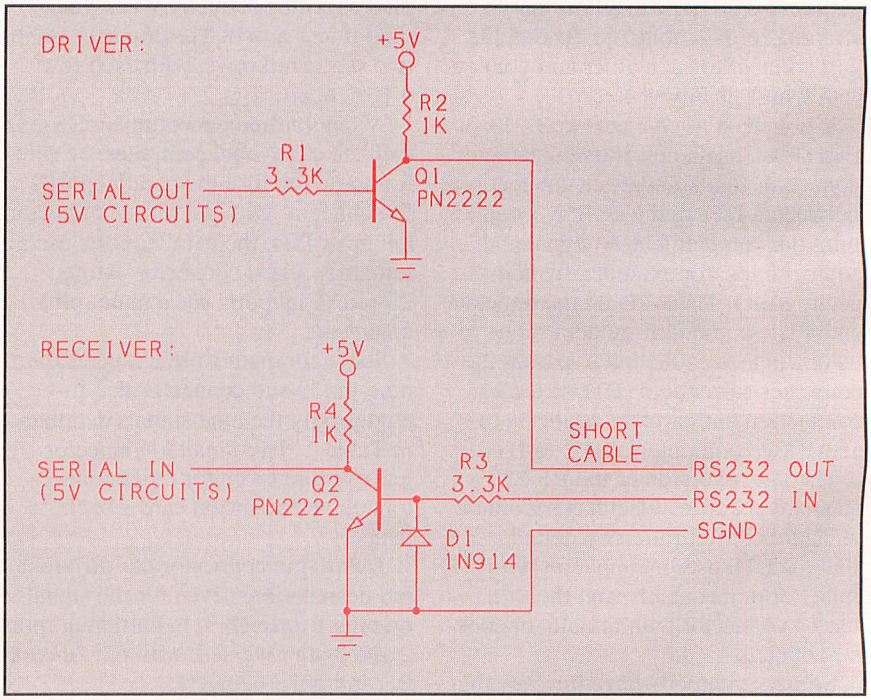


Fig. 2. You can use this inexpensive but non-standard 5-volt interface for low-speed, short distance, non-critical links to many RS-232 ports.

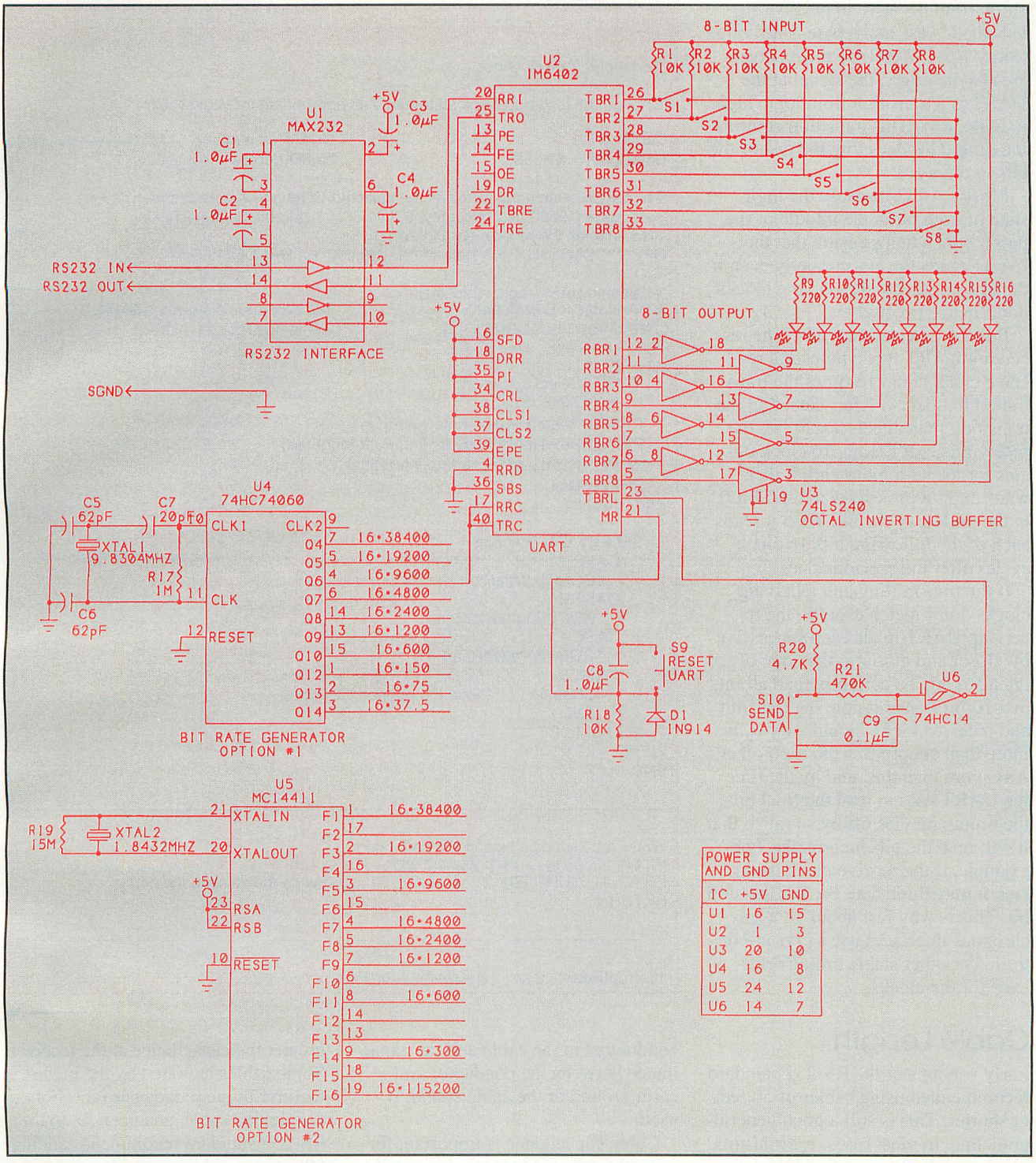


Fig. 3. A 6402 UART is a good choice in this circuit for simple monitoring and control links to a serial port.

Adding start and stop bits to a byte increases the transmission time of each byte by 25% (because you must send 10 bits instead of just eight). But an advantage is that you don't have to transmit the clock.

When idle, an RS-232 transmitter should output a negative voltage. To signal the beginning of a transmission, the line goes high for the length of one data bit, called the start bit. At 300 bps, the start bit lasts 3.3 ms, while at 1,200 bps, it's 0.83 ms, and at 9,600 bps, it's 0.1 ms.

After the start bit, the transmitter sends the eight data bits, usually beginning with Bit 0, or the least-significant bit. Since the bits use negative logic, a logic 1 is a negative voltage and a logic 0 is positive. The transmitter then sends a parity bit, if used, and a stop bit, which is a one-bit-wide negative voltage. A complete transmission, including the start, data, parity and stop bits, is sometimes referred to as a transmitted word.

At the receiving end, the first tran-

sition from negative to positive signals the UART that a byte is arriving. (Since RS-232 drivers and receivers are also inverters, the signal at the UART is a transition from logic high to logic low.) This transition controls the timing for detecting the rest of the bits in the word.

Most UARTs measure the logic state of each bit in the middle of the pulse, which helps ensure that the UART reads the bits correctly even if the transmitting and receiving clocks don't match precisely.

Bits are detected like this: The receiving UART typically uses a receive clock that's 16 times the transmitted frequency. After detecting the transition that signals a start bit, the receiving UART waits 16 clock cycles for the start bit to end. It then waits eight more cycles to read Bit 0 in the middle of the bit. Then it reads each of the following bits 16 clock cycles after the previous one.

If the transmitting and receiving clocks don't match exactly, the receiving UART reads each successive bit closer and closer to the edge of the intended bit. To correctly read all bits in a 10-bit transmission, the transmit and receive clocks should vary by no more than about 3% from each other. Any more than this, and by the time the UART tries to read the final bits, the timing may be off by so much that it will read the bits incorrectly. For example, if the receive clock is too fast, it may think data Bit 7 is the stop bit. This is why just about all asynchronous interfaces use a crystal-controlled or other stable timing reference for the clocks.

Listing 1. Test Routines for Experimenting With Serial-Port I/O.

```
'Serial-port Test Routines

'Change the following three statements as appropriate for your system:

ComPort = 1                                  'COM Port number
DataBuffer = &H3F8                           'base address of serial port

'The OPEN statement initializes the selected COM port & sets communications
'parameters: 9600 bps, no parity, 8 data bits, 1 stop bit, no handshaking. It
'also enables the receive-data interrupt.
OPEN "COM1: 9600,n,8,1,bin,rs,cs0,ds0,cd0" for RANDOM AS #1

'Additional UART registers used:
IERAddress = DataBuffer + 1                  'interrupt-enable register address
LSRAddress = DataBuffer + 5                  'line-status register address

WHILE (1)
   PRINT "Select an action:"
   PRINT "Write to port                                  1"
   PRINT "Read one byte (interrupt-triggered)            2"
   PRINT "Read multiple bytes (interrupt-triggered)      3"
   PRINT "Read port (polled-no interrupts)               4"
   PRINT "Quit                                           5"
INPUT Action

   SELECT CASE Action
      CASE 1
         GOSUB WritePort
      CASE 2, 3
         GOSUB InterruptRead
      CASE 4
         GOSUB PolledRead
      CASE 5
         Close #1       'close the opened COM port
         END
   END SELECT
WEND
END

'_____
_
WritePort:  'sends a byte to the serial port
INPUT "value to send (0-255)? ", TD
PRINT #1, CHR$(TD)                           'write the value to the port
RETURN

'_____
_
InterruptRead:  'reads the serial port on interrupt
```

Cable Length

Early versions of the RS-232 standard recommended using cables of 50 feet or shorter. This is still a good general guideline. In most cases, for transmissions at up to the specified limit of 20,000 bps, you should be able to use cables up to 50 feet long without special shielding or line terminations, other than RS-232 driver and receiver chips.

Later versions of the standard eliminate the length limit and instead specify a maximum capacitance of 2,500 pF at the receiver. This value includes the capacitance of the receiver, the mutual capacitance between conductors in the cable and the capacitance between the conductor and earth ground or the cable shield, if used.

Cable capacitance is important for several reasons. Since it's an impedance, it attenuates, or reduces, signal level at the receiver. Capacitance also limits the slew rate, or how fast the voltage on the cable can change, with higher slew rates permitting faster transitions. A greater capacitance also means that a voltage change on the cable requires more current, and overall power consumption of the drivers will be greater.

As a rule, the longer the cable, the greater the capacitance at the receiver. Some cables are rated by the manufacturer in picofarads per foot. For unshielded cable, an appendix to the RS-232 standard recommends adding 50% to the cable's capacitance to account for conductor-to-ground capacitance.

If you use ribbon cable with capacitance of 15 pF per foot, assuming an input capacitance of 100 pF, the cable could be as long as 106 feet: (2,500 –100)/(15 X 1.5).

According to Maxim Semiconductor's Application Note AN-2, capacitance for a single twisted pair is around 12 pF/ft. Again assuming an input ca-

```
SELECT CASE Action
   CASE 2
      ON COM(ComPort) GOSUB ByteRead  'for reading 1 byte
   CASE 3
      ON COM(ComPort) GOSUB BufferedRead 'for reading multiple bytes
END SELECT
COM(ComPort) ON                              'BASIC will now check the COM port
                                             'for received data after executing
                                             'each statement
PRINT "Press any key to return to main menu"
DO: S$ = INKEY$: LOOP WHILE S$ = ""
RETURN

'-------------------------------------------------------------------------
ByteRead: 'Reads and displays a received byte in decimal and hex formats.
RD$ = INPUT$(LOC(1), #1)                     'read the serial-input buffer
PRINT "data received = "; ASC(RD$); " decimal; "; HEX$(ASC(RD$)); " hex"
RETURN

'-------------------------------------------------------------------------
BufferedRead:  'waits for 3 bytes to arrive, then reads and displays all
NumberOfBytes = 3
IF LOC(1) = NumberOfBytes THEN               'wait for 3 bytes to accumulate
   RD$ = INPUT$(LOC(1), #1)                  'read the serial-input buffer
   FOR I = 1 TO LEN(RD$)                     'extract each byte in the buffer
      CHAR$ = MID$(RD$, I, 1)
      PRINT "data received = "; ASC(CHAR$);" decimal;"; HEX$(ASC(CHAR$));" hex"
      NEXT I
   END IF

RETURN

'-------------------------------------------------------------------------
PolledRead: 'detects and displays a received byte; does not use interrupts
OUT IERAddress, (INP(IERAddress) AND &HFE)   'disable receive-data interrupt
PRINT "Press any key to return to main menu"
DO
   RDA = INP(LSRAddress) AND 1                  'find state of bit 0 of LSR (Received
                                                'Data Available)
   IF RDA = 1 THEN                              'if new data exists, read it
      RD = INP(DataBuffer)                      'read the UART's input buffer
      PRINT "data received = "; RD; " decimal "; HEX$(RD); " hex"
   END IF
   S$ = INKEY$
LOOP UNTIL S$ <> ""
OUT IERAddress, (INP(IERAddress) OR 1)       're-enable receive-data interrupt
RETURN
```

pacitance of 100 pF, this gives a maximum cable length of 133 feet.

For shielded twisted-pair cable, the recommendation is to triple the value of the conductor-to-conductor capacitance to account for the conductor-to-shield capacitance.

If total capacitance is within the limit, and if you use drivers and receivers that meet the RS-232 specifications, you should be able to transfer data at 20,000 bps, even over very long cables.

If you want to use a cable that exceeds the capacitance limit, you may be still able to communicate, but only at slower bit rates. And over short cables, with low capacitance, you should be able to communicate faster than 20,000 bps.

Other considerations that affect transmission speed include the software that controls the serial transmissions, including the efficiencies of the programming language and the program itself, and the ability of the serial-port hardware to handle high transmission speeds.

Serial Interfaces

In the RS-232 standard, logic levels are indicated by positive and negative voltages, rather than the positive-only signals of 5-volt TTL and CMOS logic. At an RS-232 data output (TD), a logic 0 is defined as equal to or more positive than +5 volts, and a logic 1 is defined as equal to or more negative than –5 volts. In other words, the signals use negative logic, where the more negative voltage is logic 1.

Control signals use the same voltage levels, with a positive voltage indicating that the function is ON, or asserted, and a negative voltage indicating that the function is OFF, or not asserted.

Because an RS-232 receiver may be at the end of a long cable, a signal may be attenuated or noisy by the time it reaches the receiver. To allow for this, at the receiver or input end of the link, the two logic states are defined as more positive than +3 volts (logic 0 at RD, or ON at a control input) and more negative than –3 volts (logic 1 at RD, or OFF at a control input). The logic level of an input between –3 and +3 volts is undefined.

The large voltage swings of RS-232 give a wider noise margin than 5-volt logic. For example, even if an RS-232 driver's output is the minimum +5 volts, it can vary as much as 2 volts at the receiver and still be a valid logic 0. Many RS-232 outputs have ±12-volt swings, for a much wider noise margin.

You may also hear the terms mark and space used in relation to RS-232 interfaces. Space means logic 0, mark logic 1. These terms originally referred to the physical marks and spaces made by mechanical recorders as they logged binary data.

If you want to interface 5-volt logic to a serial port, you must translate the signals to RS-232 levels. For example, many microcontrollers, including the 8051 and 68HC11, have on-chip ports for sending and receiving asynchronous serial data, but the inputs and outputs use 5-volt logic, rather than RS-232 voltages.

For a simple, trouble-free RS-232 interface, use one of the many 5-volt chips designed for this purpose. Maxim Semiconductor produced the original chip, the MAX232 dual RS-232 transmitter/receiver. Many other companies, including Harris, Texas Instruments and National Semiconductor, now have similar devices. The chips may be listed in catalogs and data books under Linear, Interface, or Special Function ICs.

The basic MAX232 chip is powered from a single 5-volt supply and includes two drivers that convert TTL inputs to RS-232 outputs and two receivers that accept RS-232 inputs and translate them to TTL-compatible out-

puts. The drivers and receivers are also inverters.

The chip contains charge-pump converters that use external capacitors to store energy for the ±10-volt supplies used by the drivers. The recommended value for the four capacitors is 1 µF, but larger values are okay.

Table 2 lists some of other popular RS-232 interface chips. Digi-Key is one source for Maxim's chips, or you can order directly from Maxim with no minimum order. The MAX232A can operate at higher speeds and can use smaller 0.1-µF capacitors. The MAX233 requires no external capacitors at all, though it costs a few dollars more.

If you examine the data sheet for the MAX232, you'll find that its RS-232 inputs don't actually require RS-232 voltages. In fact, the inputs have near-TTL thresholds, with a logic low defined as 0.8 volt or less and a logic high defined as 2.4 volts or greater (slightly above the TTL input threshold of 2 volts). This means that the noise margin of a transmitted RS-232 signal is even greater than that specified by the standard. It also means that you can use spare gates in a MAX232 as inverters at lower frequencies in a 5-volt circuit. (If necessary, add a pull-up resistor at the RS-232 input to pull a TTL output above 2.4 volts.)

Before the MAX232 came along, many RS-232 interfaces used the MC-1488 driver and MC1489 receiver. The 1488 requires positive and negative supplies. The 1489 operates from a 5-volt supply but accepts inputs of up to ±30 volts. If your circuit has the required positive and negative supplies available, and especially if you need four drivers and four receivers, the 1488/89 pair is a low-cost alternative.

Like the MAX232, the inputs of the 1489 respond to TTL-type voltages, with 0.75 volt or less for logic lows, and 2.25 volts or more for logic highs.

Since many RS-232 inputs respond to TTL signals, if your serial link is short (10 feet or less), you may be able to use a nonstandard interface that uses 5-volt logic, rather than the RS-232 voltages, as Fig. 2 illustrates. This circuit is intended only for short experimental, non-critical links, since it doesn't meet RS-232's requirements for signal levels and slew rate.

On the transmitting end, the driver is a PN2222 or other npn general-purpose or switching transistor for *Q1*. The 5-volt serial output drives the base of the transistor, with *R1* limiting base current. When Serial Out is low, *Q1* is off and *R2* pulls TD to 5 volts. When Serial Out is high, *Q1* switches on, pulling TD near 0 volt.

On the receiving side, another transistor converts the RS-232 voltages to TTL levels. The RS-232 input drives the base of *Q2*. Resistor *R3* limits *Q2*'s base current. Diode *D1* protects *Q2* by limiting the base voltage to about –0.7 volt. When RD is near 0 volt or less, *Q2* is off and *R4* pulls Serial In to 5 volts. When RD is 2 volts or greater, *Q2* switches on, pulling low Serial In.

Monitoring/Control

Shown in Fig. 3 is a basic RS-232 interface you can use to transmit and receive eight bits of parallel data. The circuit uses a 6402 UART. Also included are a MAX232 interface and a choice of a 74HC4060B 14-stage binary counter or MC14411 bit-rate generator for the transmit and receive clocks.

At MAX232 *U1*, if your computer has a 25-pin DTE (male) connector, wire RS-232 IN to pin 2 on the connector, wire RS-232 OUT to pin 3 and wire SGND to pin 7.

6402 UART *U2* is an older device from RCA. Sources include Unicorn, JDR and Jameco. Ask for a data sheet when you order. This chip is convenient for basic monitoring and control links because it has separate transmit and receive lines. Other UARTs, like the 8250 series used in most PCs, are designed for interfacing to a computer's data bus and have a single set of bidirectional data lines.

74HCT4060 *U4* provides an inexpensive way to generate an accurate clock for timing the transmissions. With a 9.8304-MHz crystal, the outputs enable you to select the popular baud rates shown. You must use a high-speed CMOS version for the 4060 (74HC or 74HCT), not the original 4000-series (4060B). Maximum clock frequency of the 4060B at 5 volts is just 1 MHz, compared to 24 MHz for the 74HCT4060. The selected output of the 4060 sets the rates for transmitting (TRC) and receiving (RRC) at the 6402. Since the UART divides the output by 16, the baud rate is 16 times the actual frequency of the

selected output.

If you have trouble getting the crystal to oscillate, experiment by varying the values of *R17*, *C5*, *C6* and *C7*.

Motorola's MC14411 bit-rate generator (*U5*) is another option for generating the clocks. It enables you to select any of 16 bit rates in four ranges, but it's more expensive than the 4060 circuit.

Another option is to use the 6403 UART, which has an on-chip oscillator. You can connect a crystal directly to pins 17 and 40 and set low pin 2 to divide by 2,048 or high to divide by 16. I used the 6402 because it's much more widely available.

Five control inputs on the 6402 let you select the number of data bits (CLS1, CLS2), stop bits (SBS) and parity type (PI, EPE) for transmissions. A logic high on CRL loads these inputs into the control register. Figure 3 shows these inputs wired for the popular format of eight data bits, one stop bit and no parity.

Inputs TBR1 through TBR8 hold the parallel data to transmit. For testing, you can connect a normally-open switch and pull-up resistor to each bit, as the schematic shows. A low pulse at input –TBRL causes the data at TBR1 through TBR8 to appear in serial format at output TRO, in the format selected at the control inputs.

To transmit a byte, you press and release *S10*. Pressing this switch causes *C9* to slowly discharge through *R21*, bringing low pin 1 of *U6* and removing any switch bounce that might occur as the switch contacts close. On releasing the switch, *C9* slowly recharges through *R20* and *R21*, and pin 1 of *U6* goes high again. 74HC14 Schmitt-trigger inverter *U6* creates a clean pulse at pin 2's output, even if pin 1 changes very slowly.

Instead of *S10* and the components that connect to it, you can use any low-going pulse of at least 100 ns.

In the other direction, input RRI accepts serial data, strips the stop and start bits and places the data in parallel format at RBR1 through RBR8. For testing, you can connect a buffer, LED and current-limiting resistor to each output, as illustrated in Fig. 3.

The 6402 also has several other control inputs and outputs that aren't used in the Fig. 3 circuit. Outputs indicate Parity Error (PE), Framing Error, or incorrect stop bit (FE), Overrun Error, (OE) and Transmit Buffer Register Empty, or ready for new data (TBRE). Setting control input SFD high disables these outputs. Transmit Register Empty (TRE) indicates that a transmission is complete.

The Data Received output (DR) indicates that a character has been received, and the Data Received Reset input (DRR) clears DR.

These signals don't correspond directly to the control signals on the 8250 UART, but you could use them by connecting them to unused control lines and reading from or writing to them by accessing the appropriate registers in the PC's UART. Of course, you must add a wire in the cable and an RS-232 driver or receiver for each line you add.

Instead of the switches and LEDs shown in Fig. 3, you can connect any 5-volt TTL or CMOS inputs to TBR1 through TBR8, and similar outputs to RBR1 through RBR8. In the July/August and September/October 1994 issues of *MicroComputer Journal*, I included several examples of parallel interfaces that you could adapt to this serial interface.

For very simple applications, in which you need no more than four input and two output lines, you can skip the external UART and read from and write to the control signals directly. The September/October issue of *MCJ* includes an article that explains how to do this.

Test Program

Listing 1 is a *QBASIC* program that lets you test the Fig. 3 circuit by writing to and reading from a serial port. You can use these routines as a foundation for developing specific serial-port applications.

Serial programming is relatively easy in BASIC, because the OPEN COM statement takes care of many details, including setting the communications parameters, selecting a COM port and even creating buffers to store incoming data until you have a chance to read it. (These buffers are different and can be much larger than the 16-byte buffers in the 16650 UART.) BASIC also includes tools that make it easy to store received data in a file for later processing.

The program performs four operations that illustrate different ways of accessing a port. I'll describe the basic reasoning behind the program's

operation. For more details on specific statements, see your BASIC programming manual.

To write to the port, you type a value from 0 to 255. A PRINT statement writes the value to the COM port, and you should see the value at RBR1 through RBR8 on the 6402. To read the port, you can choose between an interrupt-triggered or polled interface. For interrupt-triggered reads, you can choose between reading each byte as it arrives or waiting for three bytes to accumulate before you read any of them.

Since the OPEN COM statement automatically enables the receive interrupts, you don't have to. The program also performs these three functions:
COM(1) ON enables event trapping on the specified serial port. When a character arrives at the serial port, the subroutine named in the ON COM(1) statement executes.
ON COM(1) GOSUB... names the subroutine to execute when the CPU detects a receive-data interrupt at the serial port. To read a single byte, the ByteRead subroutine uses an INPUT$ statement to read the serial-port buffer. To display the value, an ASC function converts the string variable in the buffer to the numeric value of the code. (Without this step, an input of 78h would display as "x," which is the ASCII character represented by code 78h.)

To read several bytes, the BufferedRead subroutine uses the LOC function to detect when three bytes have accumulated. It then reads the serial-port input buffer, which contains a single three-byte string variable. The MID$ function extracts each byte from the buffer, and a PRINT statement displays them.

There are times when you might not want to use interrupts, such as when you don't have a free IRQ level to spare. In this case, the PolledRead routine shows how you can poll the serial port by reading the Line Control Register (LCR) in the PC's UART to determine if new data has arrived. If Bit 0 in the register is 1, new data is available in the UART's receive register. Reading the data clears Bit 0 of the LCR until a new byte arrives.

When you're through using the serial port, a CLOSE statement closes the port and disables any interrupts enabled by the OPEN COM statement.

Sources

B&B Electronics
707 Dayton Rd.
PO Box 1040
Ottawa, IL 61350
Tel.: 815-434-0846

CIRCLE NO. 120 ON FREE INFORMATION CARD

Global Engineering Documents
15 Inverness Way E.
Englewood, CO 80112
Tel.: 1-800-624-3974 or 303-792-2181

CIRCLE NO. 121 ON FREE INFORMATION CARD

Jameco
1355 Shoreway Rd.
Belmont, CA 94002
Tel.: 1-800-831-4242 or 415-592-8097

CIRCLE NO. 122 ON FREE INFORMATION CARD

JDR Microdevices
2233 Samaritan Dr.
San Jose, CA 95124
Tel.: 1-800-538-5000 or 408-559-1200

CIRCLE NO. 123 ON FREE INFORMATION CARD

Maxim Integrated Products
120 San Gabriel Dr.
Sunnyvale, CA 94086
Tel.: 1-800-998-8800 or 408-737-7600

CIRCLE NO. 124 ON FREE INFORMATION CARD

Unicorn Electronics
10010 Canoga Ave., Unit B-8
Chatsworth, CA 91311
Tel.: 1-800-824-3432 or 818-341-8833

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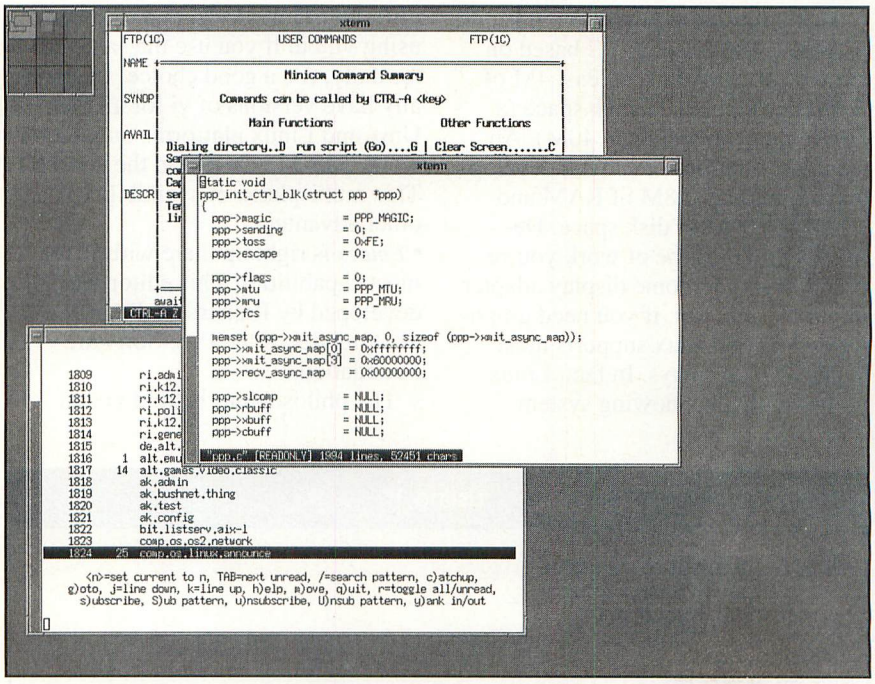
Jan Axelson

By Phil Hughes

A Multi-Tasking Development Platform For PC/Compatibles

The Unix-like Linux operating system is your no-cost entry into an alternative to DOS and *Windows*

Have you ever wanted to compile a C program, execute a previously compiled program and dial into a BBS simultaneously? One way to do this and more is with Linux, a Unix-like operating system (available for free). It offers capabilities on a par with those of commercial Unix implementations and, in many cases, beyond them. In this article, I offer a little background on Linux and show you how I've used it as a personal development platform. After reading this article, you may find that Linux is something you can use, too.



This screen capture illustrates Linux as a multitasking development system.

The Basics

The core of Linux was written by a college student named Linus Torvalds in Finland. Over the past three years, his effort has sparked the interest of thousands of programmers around the world. His work, the work of the other programmers and a set of Unix utilities developed by the Free Software Foundation have made Linux a serious alternative to a multi-thousand-dollar Unix system.

Although there's a lot more to Linux than just a development platform (see the Linux Capabilities box), in this article, I'll address only this topic. Anyone who wants to learn more about Linux and its capabilities, the More Information box lists additional resources that are worthwhile investigating.

The first step in building a development platform is deciding what it is. In my case, I wanted an editor with which I'd be comfortable, a C compiler and some communications software that would allow me to talk to other computer systems. I also needed utility programs that would let me deal with files, batch editing and a language that would let me reformat data files. Also, because MS-DOS-format disks seem to be the *de-facto* standard for information interchange, I needed to be able to format, read and write DOS disks. I also expect to be able to run any number of these programs concurrently.

These requirements are easily satisfied with any Linux distribution. I'll discuss each requirement individually:

Concurrency

To run programs concurrently, the operating system must be multitasking. Microsoft *Windows*, for example, claims to be multitasking but there's a difference between what it does and what's really needed. What you need is "preemptive multitasking" in which the operating system can interrupt a task and turn control over to another task any time it chooses. Without this capability, one program may not be able to gain control of the CPU when needed.

If you've ever run under *Windows* and pressed Alt-Tab to change tasks, you know what I mean. The task switch might be immediate or it might take several seconds or more to accomplish. Linux is preemptive and also overlaps input/output operations

0800	2	10	1.3
0830	8	60	25.3
0900	12	88	96.4
0930	14	93	113.6
1000	15	95	121.0
1030	14	90	111.5
1100	15	93	140.2
1130	13	89	106.2
1200	8	40	30.3

Fig. 1. Example of a data file that consists of a series of lines, each containing four fields.

with computing. This overlap feature alone could mean that programs run much faster under Linux than under MS-DOS on the same hardware.

The hardware required to run Linux include a 386 or better PC based on the ISA or EISA bus, at least 4M of RAM and some hard-disk space (a minimum system runs in 40M). An ideal workstation for serious development would need 8M of RAM and 100M to 300M of disk space. Depending on the type of work you're doing, a monochrome display adapter might be fine. But, if you need graphics and color, Linux supports most super-VGA displays. In fact, Linux comes with a windowing system called the *X Window System* that was developed at MIT.

X-windows is available for most Unix platforms, which makes Linux an inexpensive development platform for X-windows applications.

Editors

For me, vi is the best editor, but Linux offers choices. Here is a shopping list of what's currently available:

• ***Vi*** was developed as a screen-oriented user interface that was built on top of the original Unix line-oriented ed editor. It offers extensive editing capabilities (I wrote this article with vi, for example) with a minimum of keystrokes. Almost always cryptic, it's difficult to initially get up to speed using vi, but if you use the same editor daily, it's a good choice. I personally have versions of vi for all the Unix and Linux platforms on which I work, plus MS-DOS and the Atari ST. This multi-platform availability is another advantage.

• ***Emacs*** is right up there with vi for most capabilities. This editor was developed by Richard Stallman, the founder of the Free Software Foundation.

The philosophies behind vi and Emacs are quite different: vi offers a way to use external commands to accomplish tasks (for example, sorting part of the file you're editing). Emacs is a much larger editor that has many built-in capabilities.

• ***joe*** and ***pico*** are small and easy-to-learn, making them good choices for the newcomer. For basic editing, joe and pico seem fairly similar. Joe, however, offers capabilities beyond those available in pico.

C Compiler & Support Programs

A complete C development system needs to include a compiler, linking loader, make utility and support programs. The following is a basic list of some of the capabilities included with Linux:

gcc—C compiler (from Free Software Foundation)
g++—C++ compiler (from Free Software Foundation)
ld—linking loader
ar—object library maintainer
nm—namelist print (displays symbols in object files)
gdb—symbolic debugger
make—program group maintainer
RCS—revision control system

Make is a program that handles dependencies between various modules. For example, if your C source program dog.c includes the files animals.h and terrain.h, you'd say that object program dog.o depends on these .h files. This means that if animals.h or terrain.h are modified, you need to recompile dog.c. Once you establish these dependencies in a make file, the make utility automatically generates the necessary commands to keep your programs up-to-date.

Make is fairly common outside the Unix/Linux community and is included in Borland's Turbo C. RCS, on the other hand, is very much an animal of the Unix community. RCS lets you keep multiple versions of a program in one set of source files. This is extremely handy if you have multiple people who are updating the same source files or if you have to keep the source code up-to-date on more than one version of your program. For example, if you have a program that runs on different machines that have slightly different hardware, RCS

Listing 1

```
BEGIN   { # initialize variables
          low_events = 99999
          high_events = 0
          print "Time          Load/Users"
          print "------        ----------------"
          }

          {
          count++             # count input records
          # save values in variables
          time = $1
          users = $2
          events = $3
          load = $4
          load_total += load# cummulative load
          # if load > 100, print time
          if (load > 100) print "                    load =" load " at " time
          # check for new low and high
          if (events < low_events) low_events = events
          if (events > high_events) {
                    high_events = events
                    high_time = time
                    }
          print time "    " load/users
          }

END       { # all data read, print final report
          print "Highest event count was " high_events " at " high_time
          print "Average load was " load_total / count
          }
```

Linux Capabilities

Though there exists more than one Linux distribution, each generally includes the following capabilities. Note that because Linux includes most of the features of both BSD and System V Unix and meets most of the POSIX requirements, it's relatively easy to port other software to Linux.

Operating System
*Multi-user, multi-tasking kernel
*Network File System (NFS)
*MS-DOS file system
*ISO9660 (CD-ROM) file system

Utility Programs
*Shells (command interpreters). including the Bourne Again Shell (aka bash), tcsh, ash, zsh and public-domain korn shell (pdksh)
*File-access and -manipulation utilities
*Compression/decompression programs
*Text editors

Communications
*TCP/IP networking over Ethernet
*Internet access programs, including telnet, ftp and lynx
*SLIP and PPP networking over serial ports
*PLIP networking over parallel (printer) ports
*uucp Unix-style computer-to-computer communication
*Interactive terminal emulators

Software Development
*C compiler and linking loader
*make and Revision Control System (RCS)
*Fortran and Pascal translators
*Symbolic debugger

Graphical User Interface
**X Windows System*
*X-windows development tools
*X-windows based versions of editors and debuggers
*TCL/Tk development environment
*X applications, including drawing programs, PostScript viewer and graphical display

Text-Formatting Systems
*TeX and LaTeX
*groff (Free Software Foundation's nroff/troff suite)
*ispell spell checker

Data Manipulation
*awk data-manipulation language
*sed batch editor
*sort
*file-comparison utilities

Emulators & Compatibility Libraries
*DOSEMU MS-DOS emulator
*Wine Microsoft *Windows* Emulator (in development)
*iBCS2 libraries (for running executables from Intel-x86-based Unix systems

Miscellaneous
*Electronic mail (e-mail)
*Usenet news systems (Cnews and INN)
*Usenet news readers, including tin, trn and nn

could handle management of the source code.

If C isn't your cup of tea, other language processors are available, including Fortran, Pascal and even assembler.

Communications

A terminal-emulation program that supports such common transfer modes as Kermit and zmodem is the minimum requirement for communications. One program included with most distributions is *minicom*.

Minicom looks much like the MS-DOS communications package called *ProComm* and has the same menu-oriented interface and generally the same keystroke commands to access the menus.

While *minicom* offers the ability to interactively connect to other computer systems and to request file transfers, I regularly use one other capability and plan to use a second in the future. The one I currently use is called uucp, which stands for Unix-to-Unix Communications Program. It offers a way to have two computer systems automatically transfer files and electronic mail without the need for any intervention.

The uucp protocol was developed in the early days of Unix when dedicated computer connections weren't needed and the costs associated with the connections were prohibitive.

Even today, uucp is the primary connection for the transfer of Usenet newsgroups, as well as e-mail for many computer systems. Uucp on my home system offers a link to the outside world with a minimum of intervention on my part and no cost beyond occasional use of a standard dial-up telephone line.

The capability I intend to take advantage of in the future is the ability to connect directly to the Internet over a dial-up serial line. Linux includes both SLIP (Serial Line Internet Protocol) and PPP (Point-to-Point Protocol) program suites. SLIP has been around for years, but it has never really become a standard and has limitations. PPP has been gaining acceptance. If PPP service is available from your service provider, it's currently the best choice.

Once you establish a SLIP or PPP link, you've brought all the capabilities of the Internet directly to your own computer. Because Linux includes all the support programs—such as ftp for direct file transfers, telnet and rlogin to remotely log into systems on the Internet and such other utilities as nslookup to look up machine addresses and even lynx, a World Wide Web browser—you no longer need to interactively dial up a BBS or Internet service provider, access the files you want and then download them to your local PC. You can perform the tasks directly on your machine.

To make all of this go together, some utilities are required. Character-conversion utilities, file-comparison utilities and batch-editor and file-manipulation programs are on my list of requirements.

Data Formatting

The ability to format and manipulate data could be as simple as reading data records and printing some column totals or as complicated as a complete reformat of the information. Although data formatting could be done in C, the Free Software Foundation's version of awk, called "gawk," is included with Linux. This program offers a very-powerful language that's specifically designed to perform data-manipulation tasks. It combines the capabilities of regular expressions, a pattern-matching language that's also available in many other utility programs for quick selection with a C-like language geared specifically for working with character strings.

Having worked with awk for close to 10 years, I find it easy to learn, powerful enough for very-complicated data manipulation and fast enough for many production jobs. Its ability to work with associative arrays (arrays in which subscripts can be any string, rather than just a set of contiguous integers) offers easy solutions to many complicated tasks.

The following example will give you the flavor of awk. The data file shown in Fig. 1 consists of a series of lines, each with four fields. It's the output of a data-collection program in which the fields are a time stamp, a user count, an event count and a load average. The awk program shown in Listing 1 produces a report made up of: an output line consisting of the time and load average divided by the user count for each input line; an output line for each input line in which the load average is greater than 100; a summary that displays the highest event count (and time); and the total load divided by the number of samples. If the data is in the file data and the program is in awk.prg, you could execute the program by entering the command:

```
awk -f awk.prg data.
```

The result is shown in Fig. 2.

```
Time    Load/Users
----    ----------

0800    0.65
0830    3.1625
0900    8.03333
                    load =113.6 at
0930
0930    8.11429
                    load =121.0 at
1000
1000    8.06667
                    load =111.5 at
1030
1030    7.96429
                    load =140.2 at
1100
1100    9.34667
                    load =106.2 at
1130
1130    8.16923
1200    3.7875
Highest event count was 95 at 1000
Average load was 82.8667
```

Fig. 2. Result obtained from the program given in Listing 1.

DOS File Access

MS-DOS disks are a very common tool for exchanging information between computer systems. The ability to read and write MS-DOS disks is required. Linux offers two separate avenues for accessing these files.

The first, called mtools, is a suite of programs that let you format MS-DOS disks, create and remove directories and read and write files. You use these programs much like the MS-DOS or Unix command-line commands. For example, to copy the file article.txt from the MS-DOS disk in drive A: to your current directory on the Linux system, you enter:

```
mcopy A:article.txt .
```

Or you could perform the same copy and rename the file to my.article.from.dos with the command:

```
mcopy A:article.txt my.article.from.dos
```

The second avenue for accessing MS-DOS files comes from the ability of Linux to support different types of file systems. For example, as well as its native file system types, it supports the ISO9660 format used on CD-ROMs. MS-DOS is another type of file system you can access.

To use this capability, you mount the file system, a process that makes MS-DOS disk appear as a directory in the standard Linux file hierarchy. You can then read and write files just as you would with any other Linux file, the only limitation being those imposed by the file system itself. In the case of MS-DOS, the major limitation is the restriction that file names are only eight characters in length and have a three-character extension.

Let's look at an example. If you want to mount an MS-DOS floppy disk from Linux, you need to know the Linux name for the floppy-disk drive and decide where you want the contents of the MS-DOS disk to appear in your file hierarchy. Assume the Linux name for the floppy drive is /dev/fd0 and you want the disk to appear in the directory /dosA. All you

More Information

The primary source of information on Linux are the comp.os.linux newsgroups on Usenet. The code is freely available via ftp access on the Internet from sunsite. unc.edu, tsx-11.mit.edu and many other sites around the world. Other sources of information, software and code include:

**Linux Journal.* This international magazine covers the Linux community. Articles include technical material, help on getting started and interviews with Linux personalities. Subscription is $19 per year from Linux Journal, PO Box 85867, Seattle, WA 98145-1867 (tel.: 206-527-3385 or via electronic mail at subs@ssc.com). *Linux Journal* is published by SSC, which also sells printed copies of various *Linux Documentation Project* books and papers, Linux on CD-ROM and other Linux accessories.

***Free Software Foundation**. This nonprofit organization (tel.: 617-876-3296) is in charge of the GNU project. (GNU is a recursive pun that means GNUs Not Unix.)

Vendors of Systems with Linux Installed:

*Fintronic—415-325-4474
*PromoX Systems—408-733-2966
*SW Technology—214-907-0871

Vendors of Linux Distributions:

*InfoMagic—800-800-6613
*Linux Systems Labs—800-432-0556
*Morse Telecommunications—516-889-8500
*Prime Time Freeware—408-433-9662
*Red Hat Software—919—309-9560
*Singum Support AB (Sweden)—+46 (0) 13-21 4600
*S.u.S.E. (Germany)—+49-911-7405331
*Trans-Ameritech—408-727-3882
*Yggdrasil—800-261-6630

need do is insert the disk and issue the command:

```
mount -t msdos /dev/fd0 /dosA
```

You can then access the files directly. For example, to display the contents of the floppy using the Linux ls (list) command, you'd enter:

```
ls /dosA
```

This ability to mount an MS-DOS file system also means that if your computer has both Linux and MS-DOS on its hard disk, you can mount your MS-DOS partition or partitions under Linux and directly read and write your MS-DOS files. I use this capability to back up my MS-DOS files, using the Linux backup utilities.

Conclusions

In this article, I've only scratched the surface of what Linux offers. By looking at how Linux could serve as a software-development platform, you've seen only one possible way to apply all of this free technology. As I write this article, thousands of people around the world are thinking up new uses for Linux, developing new software for it and fixing existing bugs.

Linux couldn't have been created by one person. It's too complete, too good and too reliable to have even been created by most companies. It's a cooperative effort from contributors around the world, connected by the Internet, that made Linux what it is today. And the work goes on. Even as commercial products continue to be ported to Linux, the free parts of the operating system continue to evolve.

If you've ever wanted a Unix-like operating system for your personal use or an inexpensive way to get your company moved over to Unix-like platforms, it's probably time for you to join this movement. Linux offers a chance for everyone to contribute and for everyone to benefit. ■

Software Review **By Tom Fox**

Mathcad 5.0: Math Program With Sophisticated Text-Handling Capabilities or a Special-Purpose Word Processor With Sophisticated Math Capabilities?

I first used *Mathcad* 1.0 way back in 1986. I recently looked at Version 1.0 again to make a comparison with the recently-released Version 5.0. My impression is that, except for the comparatively crude user interface (CGA/poor EGA quality screen), *Mathcad* 1.0 is still a useful program. Actually, Version 1.1, which was an update sent free of charge, could do most of the number crunching the latest version does. Other than taking up nearly 50 times more disk space (300K *vs.* 15M), the primary obvious difference is that Versions 3.0 and later could do symbolic equations (the type done by pure mathematicians), while earlier versions were solely number crunchers. The other major difference, of course, is that since Version 3.0, *Mathcad* has been either a *Windows* or Macintosh version.

To be honest, the *Windows* version has been a boon, especially to those of us who don't use *Mathcad* on a daily basis. While the *Windows* version includes multiple document interface (MDI) that lets you keep several files open simultaneously and permits simple cut and paste between documents, it's the operator palette along the left edge of the window that's the star! With that dazzlingly beautiful set of pixels along the left edge of the screen, you don't have to remember often-arbitrary keystroke designations. While I've never forgotten that a colon (:) produces the logical equivalent of an = sign and the = sign itself is used as a "compute" command to instruct *Mathcad* to calculate an answer, when it comes to things like the integral sign or, say, even π (3.14159...) I had to look it up somewhere. Now with that gorgeous operator palette, you just point and click!

It took nearly 2½ years for Mathsoft to upgrade *Mathcad* from its 2.5 DOS version to its 3.0 *Windows* version. Since *Mathcad* 3.0, Mathsoft has been turning upgrades out rather furiously—three additional versions have appeared: 3.1, 4.0 and 5.0.

Versions 3.0 through 5.0 of *Mathcad* have more similarities than differences. Normally, one would assume that the latest version would have more features. This is only partially true with *Mathcad*. Version 5.0 has many more features than Version 3.0. However, SmartMath, a major feature, was introduced with Version 4.0 but is omitted with the standard Version 5.0. As far as I know, SmartMath, as implemented in Version 4.0, wasn't buggy, although on my minimal system, when SmartMath was loaded my hard disk seemed to work like an over-busy ant! Rather, it was the bottom line that likely caused this deletion from Version 5.0. With release of Version 5.0, Mathsoft has created a new category of software; its "Plus" version. Now SmartMath is included with only *Mathsoft Plus* 5.0. In very simple terms, when SmartMath is turned on, SmartMath uses its collection of rules (built-in "smarts") to determine the best way to solve a problem and whether *Mathcad* should rely on its symbolic or numerical engine.

Mathcad 5.0 can now be used as a special-purpose word processor that prints just about any mathematical symbol, including all the Greek characters, although only the most commonly used Greek characters are on the palettes. It has been rather obvious since *Mathcad* 3.0 that Mathsoft was rapidly expanding the text-manipulation capabilities of *Mathcad* . With *Mathcad* 1.0, text handling seemed to be an afterthought. However, with Version 5.0 and inclusion of a sophisticated spell checker, headers and footers and automatic page numbering, print preview and improved text editing, *Mathcad 5.0 can now be* looked at in one of two ways: as a sophisticated scratch-pad type math program or as a mathematical word processor with sophisticated mathematics capabilities. I imagine this is Mathsoft's goal to increase their sales potential and I'm not surprised to see the marketing people at Mathsoft attempting to push the word-processing capabilities of *Mathcad* 5.0. For those of you who are into advanced math, Mathsoft also sells *Mathcad* Plus 5.0 along with *Maple V*. My personal feeling is that the potential market for advanced mathematics software is limited and stagnant, while the potential market for a mathematics word processor with advanced mathematics capabilities is large and increasing.

Mathcad 5.0 Overview

This program ($495 list, less than $290 street) requires a minimum 80386SX PC/compatible, with 4M of RAM and 14M of free hard-disk space and an additional 1M of space on the hard-disk space on which *Windows* is installed. It's recommended that you also have at least 8M of virtual memory, although this can be configured as either a permanent or temporary swap file. It also requires a mouse along with *Windows* 3.1. The system I tested it on is nearly the minimal system described—a 16-MHz 386SX with 8M of RAM and no math coprocessor.

On a bare-bones minimal system, *Mathcad* is plenty fast for even moderately complex math without graphics. However, once you display graphics, either a plot or imported, *Mathcad* slows up significantly. Take heart here. By simply doubling RAM (from 4 MB to 8M) things speed up greatly. For instance, on my minimal system with only 4 M of RAM, moving about a document with graphics is so slow as to be on the verge of being unacceptable.

However, with 8 M of RAM and my otherwise minimal system, *Mathcad*'s speed, even with a document heavily loaded with graphics, is acceptable to me.

As with its other three *Windows*-based ancestors (3.0, 3.1 and 4.0), *Mathcad* 5.0 comes with a professional program that makes its installation to hard disk a snap (Fig. 1). To put things into perspective, *Mathcad* 1.0 and 1.1 didn't come with an installation program. However, their programs were so compact that they each could fit on a single 360K 5¼" disk, although Version 1.1 came with an auxiliary disk of sample documents. These early programs could either be run from the original floppy or the files could be simply copied onto a hard disk. As a comparison, *Mathcad* 5.0 comes on five 1.44M 3½" disks crammed with compressed data! (*Mathcad* 4.0 was able to fit on three 3½" disks.)

Brand new with *Mathcad* 5.0 is a short animated tutorial. While short at less than 10 minutes and simplistic with little substance, it's fairly effective in introducing an individual educated in traditional mathematics to *Mathcad*. This tutorial is funny. It's a rather painless and fairly humorous introduction to *Mathcad*.

Mathcad's hefty manual (it contains more than 800 pages) is extremely well-written. It seems to combine a tutorial and reference in one easy-to-read text and is loaded with examples and screen shots that should be able to turn someone knowledgeable in mathematics into a *Mathcad* expert in just a few days. Don't be misled here, though. The animated tutorial or manual doesn't teach you mathematics; just about *Mathcad*. If you don't have any idea what an eigenvector is before reading the manual, you still won't after reading it! (If your math knowledge is weak but your desire for math knowledge is strong, look into *Mathcad*'s new educational Electronic Book series.) The only meager complaint I can make with the manual is that I'd appreciate a more-complete index. You'd think an 18-page Index would be sufficient but it isn't here. For instance, while there's a complete chapter on importing graphics, I couldn't find any reference to it in the index!

Mathcad 1.0 started out as a mathematical scratch pad and quickly dominated this niche market. Although you can still use it as such, *Mathcad* 5.0 is more than a scratch pad. It's a mathematical word processor with advanced mathematical capability. However, unless you want to produce a slick and professional-appearing math paper, is it really necessary? If you aren't doing some really intense math problem, might a good scientific calculator and a pad of paper do just as good? Also, can't you get most jobs done quicker with a calculator and a pad of paper than with *Mathcad* operating on a 100-MHz Pentium PC? The answer here, I suppose, depends upon the individual. Personally, I think *Mathcad* is a wise choice when trying to solve even relatively simple design problems. While it won't make you give up your calculator or put pencil manufacturers out of business, it does make you think more logically and proceed more orderly. Its range values feature and its graphing capabilities are time savers—with *Mathcad*, it's nearly as easy to make calculations with 1,000 different resistor values as it is with one.

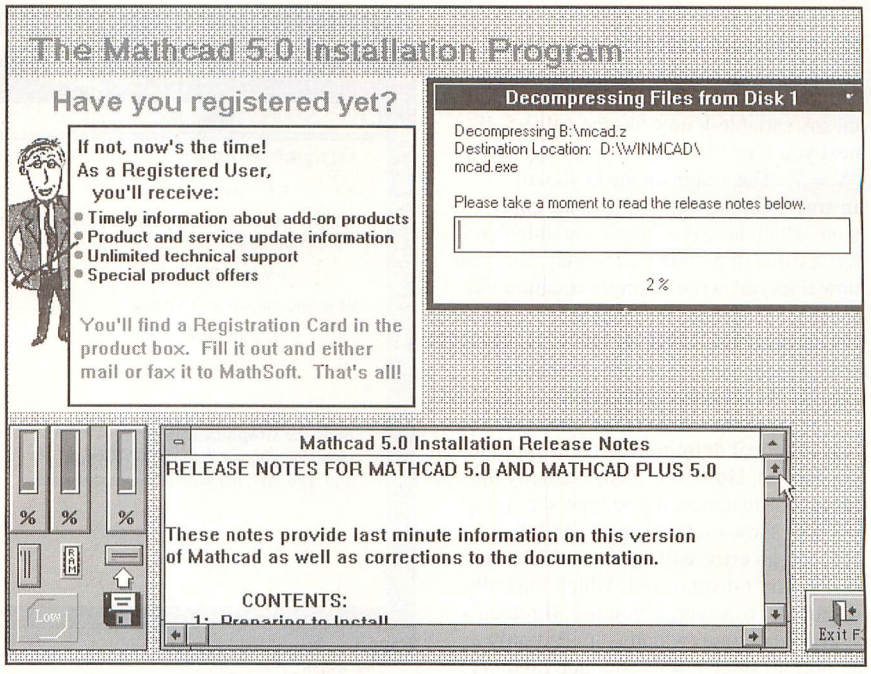


Fig. 1. *Mathcad* 5.0's installation screen.

Nonetheless, the greatest time-saving ability concerns *Mathcad*'s indirect effect on behavior, rather than the more-direct obvious effect of speeding calculations. For instance, since *Mathcad* makes repeated calculations so effortless, a designer has a greater incentive to undertake copious calculations that usually (there are exceptions) results in a more-careful mathematical analysis of a problem. Often, this reduces the need for modifying the design of the prototype system. One possible negative result, often overlooked, with careful mathematical design is that it tends to reduce the number of major breakthroughs made through happenstance. Despite their reality, these breakthroughs are sometimes thought of as "myths," possibly because of their rarity. As a practical matter, it's difficult to justify increased development costs simply to increase the slim chance of a major breakthrough through blind luck.

Mathcad 5.0 has so many math features that I don't have room enough here to mention all of them. So what I'll do is highlight those features I feel will be of most interest to you. The following is a very abbreviated list of these:

- Solves most commonly used equations (numerically and symbolically) including simultaneous equations and inequalities.
- Handles units and does dimensioning checking.
- Takes derivatives, integrals, most FFT's, does iteration, works with octal, hexadecimal and complex numbers.
- Provides many statistical functions and performs many vector and matrix operations (even finds eigenvalues and eigenvectors)
- Includes trigonometric, hyperbolic, exponential and Bessel functions.
- Creates just about any 2-D graph you need.

Using the Program

While *Mathcad* is basically easy to use, it does have a few idiosyncrasies that can be confusing to new users. One that comes to mind concerns the simple = sign. You thought an = simply meant that whatever was on the left of the sign equaled whatever is to the right of the sign. With *Mathcad*, that's sort of true, but there's more to it. For instance, say you want to set the variable $V = 5$. If you try to type this as V = 5, using the keyboard directly, *Mathcad* simply won't let you do it! It stuns you with error messages or, if V is entered previously in your document, *Mathcad* displays the calculated value of V less than a millisecond after you hit the = key!

Of course there's a simple way to assign the value 5 to *V*. Instead of using the keyboard's = sign use the : key. Thus typing V:5 results in the display "V := 5", which means variable *V* now has the value 5. If next you type "V=", the display will show: "V = 5". The = sign on the keyboard instructs *Mathcad* to evaluate the expression, which here is a simple variable that has a value of 5. "Fine", you may say, "but how does one write a simple equation like y = x – 5?" The answer is by using a third = sign, which shows up on the screen as a bold = sign! This = sign (the Boolean = sign) is obtained by typing [ctrl]=.

The Boolean = sign is the closest to the mathematical definition of the = sign most are used to. However, it isn't exactly the same. For instance, if you type x[ctrl]=1 (x = 1 will show on the display) and then type x=, an error will show on the screen and it won't display x=1, which logically it should. However, if you use *Mathcad*'s symbolic engine (which is loaded only as an option, since it uses so much memory) and choose Evaluate Variable Symbolically from the Symbolic drop-down menu, the screen will, indeed, indicate that *x* has the value of 1. Even so, it still doesn't automatically put the equality, x=1, on the screen, and if you attempt to make things look right and type x=, you'll still get an error message!

It would be nice if *Mathcad* could somehow integrate all these equal signs into a single one so that those of us who think mathematically will find the program more congenial. There's yet another = sign that's closely related to the Assign Value to Variable sign—the one created with the colon. It's the global assignment. Instead of just two short horizontal lines this one has three. This global assignment is accomplished by typing the tilde (~) key. The only difference between this one and the assignment created by the : key is that, once a variable is defined globally, its definition applies *everywhere* in the document. While the preceding discussion may make it appear *Mathcad* is confusing, one gets use to its handling of = signs fast.

In addition to the math-related academic world, *Mathcad* is designed for technical professionals and scientists by providing unit capabilities and also does dimensional checking. Mathcad automatically displays results in terms of the MKS fundamental units (m, kg, sec, coul and K, or degrees Kelvin) even if one labels variables with other units. This is consistent. However, it isn't always the most convenient. For instance, say you want to calculate a resistance knowing the voltage across it and the current through it. From Ohm's law, this is simply R = V/I. Now say you enter V := 5 volts and I := 10 mA

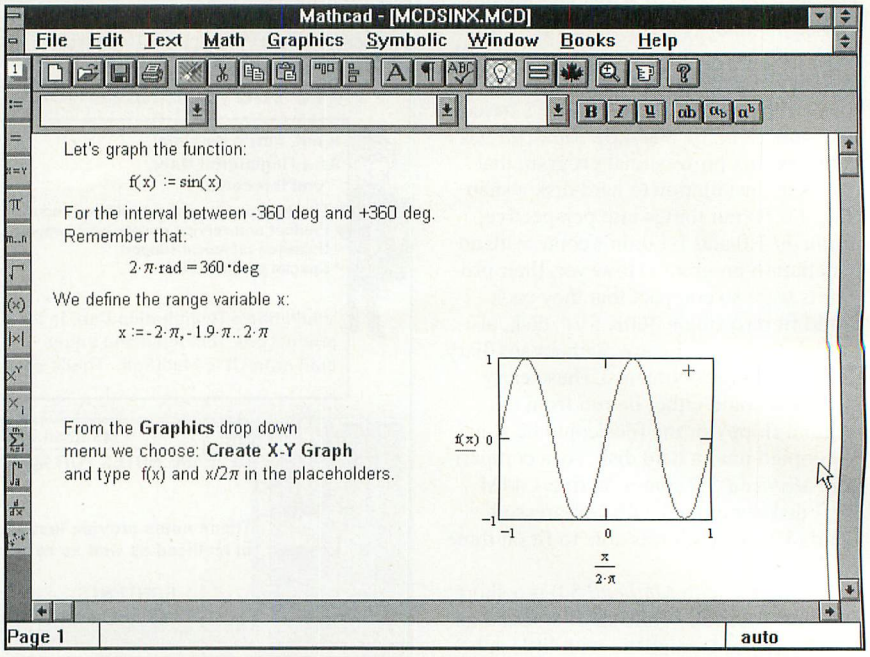


Fig. 2. This is a screen shot of the sin(x) function.

and then command *Mathcad* to calculate the answer (simply done by typing R=), what you get is the obscene R = 500*kg* m2*sec-1*coul-2! Believe it or not, these units are correct. Nevertheless, the units surely aren't your typical ones used in Electric Circuits 101! While it isn't difficult to have *Mathcad* change these rather pedantic units to the more common "ohm," it can't be done before the calculation is made.

Since in addition to being a math program, *Mathcad* can be considered a special-purpose word processor, it seems reasonable to assume that it provides for importation of graphics. There are several ways of doing this. For instance, you can paste an image from the *Windows* Clipboard. You also can import graphics indirectly by entering the name of a file containing graphics information. Pasting from the Clipboard is simple for the *Windows*-smart. For instance, if you created an image with Paintbrush, select the drawing with the cutout tool and choose Copy from the Edit menu. Then in *Mathcad*, choose Paste from the Edit menu.

The other way to import an image is through a separate file. Here, choose Create Picture from the Graphics menu and type the name of the file containing the graphic information. This graphic file must be in .BMP format. If the file isn't in the same directory as *Mathcad*, things get slightly more complicated and you must use the Associate Filename procedure, which is clearly explained in the manual.

While you can import graphics into *Mathcad*, except for graphs and plots, the program doesn't have typical graphic tools. I believe such a program would benefit from including a few drawing tools, as many as some of the popular spreadsheets do today. Really, what is a scratch pad without a few well-placed, pertinent scratches and scribbles?

It's simple to create graphs and plots with *Mathcad* (Fig. 2 indicates how to create a simple graph of the sine function). *Mathcad* supports just about every 2D graph and plot you'll want, including function graphs, vector graphs, multi-expression graphs, polar plots and even contour plots. Many options are available, such as logarithmic scale, bargraph (the default is a line graph), color and many others.

The only problem with the graphs is that they're faint and lack a finished appearance. As you can see in Fig. 2, fine details that you'd expect in a state-of-the-art *Windows* program are missing. Except for being much neater, they look a lot like the graphs I make on my own scratch pad with a No. 2 pencil. In fact, the graphs produced by *Mathcad* 5.0 are similar to the ones produced by the original *Mathcad* 1.0, which I felt could use improvement back then. While the present graph is fine for a quick check of a math problem, it would be nice if *Mathcad* included another more-detailed graph-creating routine that would include presentation-quality graphics.

Text Capabilities

In the promotional literature, *Mathcad* 5.0

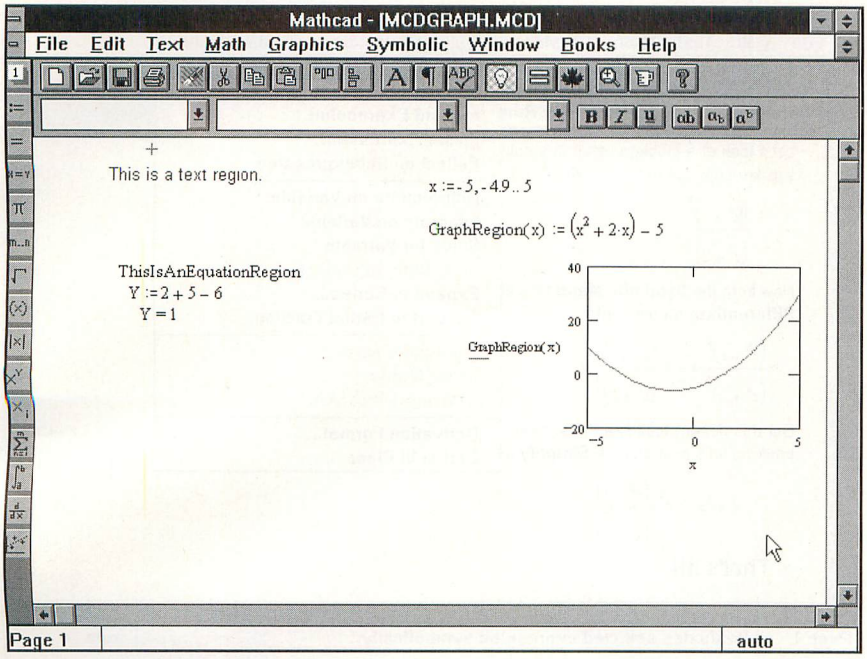


Fig. 3. This screen shot shows *Mathcad*'s regions.

stresses its word-processing capabilities. While you can create a document that contains text with sophisticated mathematical equations, the two can't be mixed. Separate text regions must be created. A *Mathcad* document is composed of a collection of regions. In addition to text regions, there are equation regions, plot (graph) regions and graphic (picture) regions. In a printed document, the regions seem to merge. These regions are so seamless that separate regions aren't discernible to even a meticulous observer. Since *Mathcad* creates an invisible rectangle to hold each region, one normally can't see the different regions. If you wish to see the regions, choose View Regions from the Edit menu, as illustrated in Fig. 3.

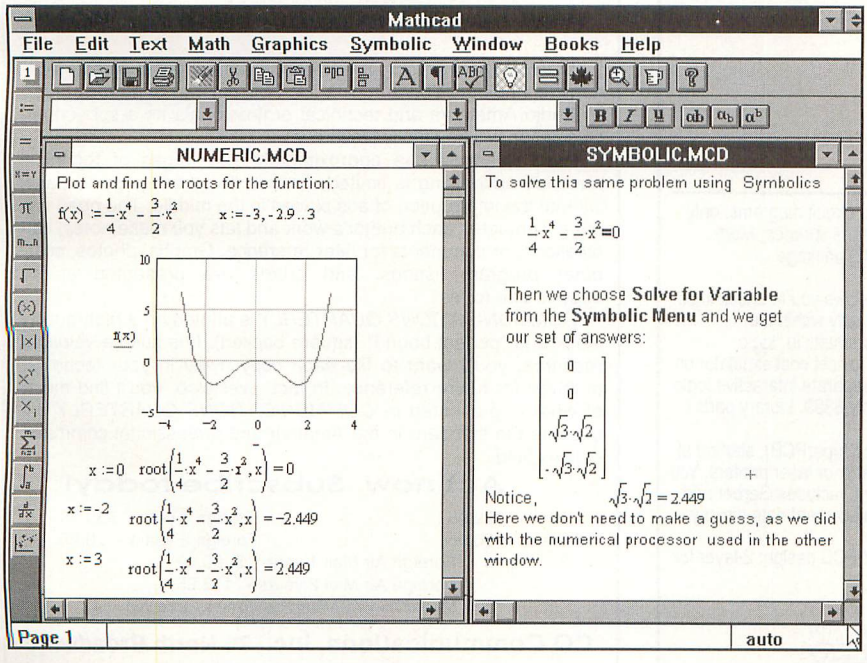


Fig. 4. Comparison of *Mathcad*'s symbolic and numerical engines as they solve the same problem.

Mathcad can display in standard format just about any mathematical equation you can think of. Unless the equation is simple, the equation must be in the equation region and *not* the text region. The reason is that *Mathcad*'s sophisticated math symbols can be used in only an equation region. However, Greek characters can be used in both text and equation regions. *Mathcad*'s text is formatted using the Rich Text Format (RTF) specification. Thus, you can export the text from *Mathcad*'s text region to any word processor that can read files in RTF format. While you can't export data from an equation or plot region in this manner, any region can be exported using the *Windows* Clipboard to a word processor concurrently running under *Windows*.

Mathcad is a quantum leap ahead of *WordPerfect* 5.1's Equation Editor. Unlike *WP*'s Equation Editor, it not only is a snap to write an equation with but, unlike the Equation Editor, it can solve it—at least most of the time.

When they hear about *Mathcad*, most people think of numerical calculations. For *Mathcad*'s first five years of existence, this was true. In Version 3.0, Mathsoft introduced a symbolic processor based on the well-known *Maple* symbolic engine developed by Waterloo Maple Software, Inc. Keep in mind that *Mathcad*'s implementation of *Maple* is limited, and if you want the full implementation you'll have to purchase *Maple V* separately. To conserve memory, the symbolic processor isn't loaded when *Mathcad* starts. It's loaded by either clicking the maple-leaf icon or by choosing Load Symbolic from the Symbolic drop-down menu.

People who love mathematics will be fond of the symbolic processor. It can manipulate equations like a genuine mathematician. When asked to find a numerical solution to a problem, it will provide an exact answer, rather than a numerical approximation. For instance, for the simple equation X2 – 2 = 00, it will provide the exact answers +sqrt2 and –sqrt2 instead of the approximate answers: 1.414 and –1.414 (see Fig. 4).

Remember, the symbolic processor is separate from *Mathcad* and, when you choose a command from the Symbolic menu, *Mathcad* sends the expression to *Maple*. *Maple*'s answers are often in a different format from what you may be used to. For instance, the integral of f(x) with respect to *x* is written by *Maple* as int(f(x),x). Because of this, *Mathcad* normally converts the answer into a more-normal *Mathcad* expression. However, when the answer is too long, it's placed on the Clipboard and is displayed in *Maple*'s syntax.

One chooses from the Symbolic Menu

exactly what one wants to do, as in Fig. 5. Notice all the things you can and can't do. Can't-do options are grayed out and, thus, aren't available, usually for a logical reason. For instance, if there's no matrix in the document, Transpose Matrix, Invert Matrix, Determinant of Matrix options will be grayed out.

It's obvious that *Mathcad*, with *Maple*'s help, does a great job in math. Nonetheless, you can't expect it always to produce the simplest answer. Also, Mathcad has limitations, many of which aren't so much the limits of the program but a limit of present mathematics knowledge. For instance, according to *Mathcad*'s manual, there's no known formula, like the famous quadratic formula, that gives the roots of a polynomial of degree 5 or over Such an equation is easily solved numerically but not symbolically by *Mathcad*. It's interesting to note that, while the manual implies that *Mathcad*'s symbolic engine can't solve polynomials of degree 5 and over, I've tried several degree-6 and over equations and *Mathcad*'s *Maple* has come up with exact answers, which are displayed on the Clipboard! I made no attempt in de-

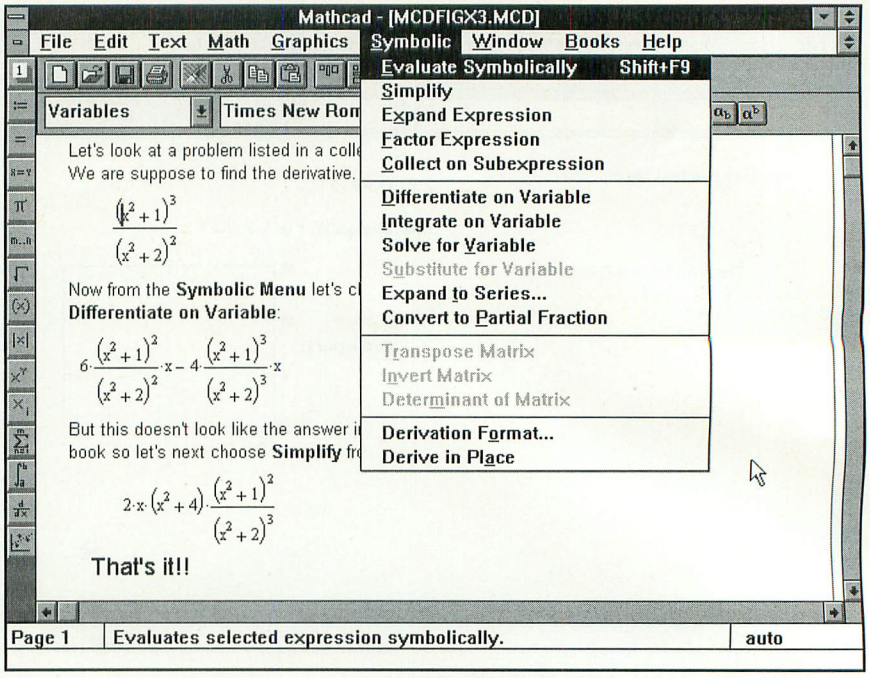


Fig. 5. Symbolic drop-down menu shows all available and non-available (shown phantomed) options.

Electronic Handbooks

Mathsoft has developed a large and growing number of Electronic Handbooks. Two are provided with *Mathcad* 5.0, the *Desktop Reference Handbook*, which was formerly called the *Standard Handbook*, and the *Book Sampler Handbook*, which as its name indicates is meant to whet your appetite for some of the other *Handbooks* Mathsoft sells. I found the sample chapter in the *Astronomical Handbook* fascinating. In it were shown equations that allow one to calculate the phases of the moon. In addition to the two Handbooks that came with *Mathcad*, I've also installed on my system the Handbook *Theory and Problems of Electric Circuits*, which is from Schaum's Outline Series (Fig. A).

Many of the Handbooks are original works and not available in standard book format. When used with *Mathcad for Windows*, these handbooks allow direct importation of "canned" formulas and graphs into your work. *Mathcad* 5.0 has made this easier than ever. In addition, you can now use the Electronic Book as a scratch pad. You won't mess up the original since *Mathcad* maintains a clean copy at any time. This is a neat feature, and it is obvious Mathsoft has high hopes of creating a steady cash flow via its Electronic Books.

On my nearly minimal system, these Handbooks operate relatively slowly, although not so slowly as to be useless. With a 386SX system that had only 4M of RAM, scrolling through a document with graphics is painfully slow, which greatly limits the Handbook's practicality. Therefore, I can't recommend these Handbooks to someone who has a minimal system (386SX, 4M of RAM and no coprocessor). Even so, I feel they're suitable for use with a 386SX, as long as it has at least 8M of RAM.

These Electronic Handbooks are not cheap. They list for from $69 to $99 each and are usually purchased directly through Mathsoft. At times, Mathsoft runs specials with prices as low as $39. It seems to me that the most useful of Mathsoft's traditional Electronic Handbooks are the ones that provide tables and reference data, such as the *CRC Materials Science and Engineering Handbook* . Recently, Mathsoft released a number of software packages for education. These include *Algebra I* and *II* and *Precalculus Electronic Books*. These packages are worth looking into if math education is your goal.

Before purchasing any Handbook, use Mathsoft for a while and see if you actually use the Desktop Reference. If not, think hard before purchasing an Electronic Handbook. Remember they not only cost you that hard-earned green stuff, they also consume valuable disk spa

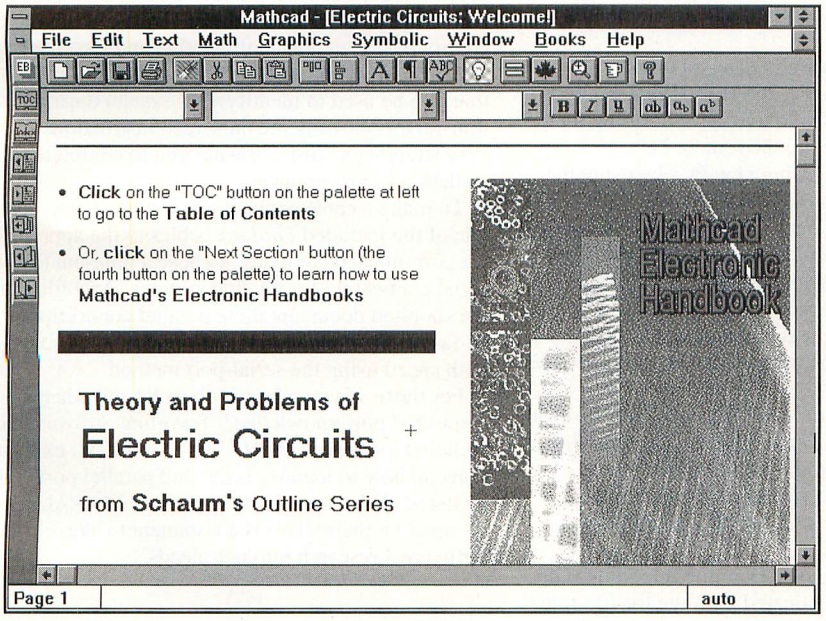


Fig. A. Screen shot of a section of the Electronic Handbook *Theory and Problems of Electric Circuits.*

Product Reviewed

Mathcad 5.0, $495
Mathsoft Inc.
101 Main St.
Cambridge, MA 02142-9785
Tel.: 1-800-MATHCAD;
FAX: 617-577-8829

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termining the accuracy of these answers.

Along with *Mathcad* 5.0, Mathsoft released *Mathcad Plus* 5.0, which is more powerful. While it still doesn't have a full-featured programming language, similar to *Mathematica*'s, there is a new C, C++ programming interface. *Mathcad Plus* is obviously designed to compete with *Mathematica*, as well as *Maple V* and other math programs. (*Maple V*, can also be purchased through Mathsoft.)

Mathcad 5.0 now has a DDE (Dynamic Data Exchange) interface. Appendix E in the manual provides several good step-by-step examples of using this sophisticated interface with Microsoft's *Excel* as one of the DDE's client applications. Despite excellent documentation, unless you're already well acquainted with DDEs, you'll probably take some time to become familiar with using *Mathcad*'s DDE capability.

User Comment

Mathcad 5.0 is highly recommended for several sets of users. It's great software for anyone in the math/science/engineering education fields, either student or teacher. It's also perfect for anyone who wants to quickly create slick-looking mathematical-based documents. The fact that it can do advanced numerical calculations and handle symbolics is a plus here. Its lack of any drawing tools and presentation-quality graphs is a minus, although it partially makes up for this with its combination of graphic file (.BMP) importation ability and full support of OLE (Object Linking and Embedding). *Mathcad* also is valuable to anyone whose math requirements varies from the basic to the advanced and who prefers a relatively simple non-programmable interface. For complex projects, you may need to supplement *Mathcad* 5.0 with *Mathematica*, *Matlab*, *Gauss*, *Derive*, *Maple V* or possibly *Mathcad Plus*. For those of us who find a scientific calculator and paper sufficient for most math needs, *Mathcad* 5.0 is a welcome sophisticated addition to a relatively simple math toolbox. ■

LapLink V: Super PC-to-PC File Transfer Via Serial Ports

By Leslee Jo Sebastian

Almost since its inception, many users have had the need to transfer files from one personal computer to another. An early solution was to use serial ports and a cable to physically link computers that were near to each other (several feet or so), and a similar arrangement plus a modem at each computer and the telephone line between the two to link computers that were physically separated from each other by long distances. Over the years, various products have been introduced to make this possible. Traveling Software has been a pioneer in this area with its very popular *LapLink* software/hardware packages. Its latest package, *LapLink* V, is ideal for transferring files from PC to PC via a serial or parallel port or modem. Whether you're using DOS or *Windows*, *LapLink* V can be up and running smoothly and easily within minutes.

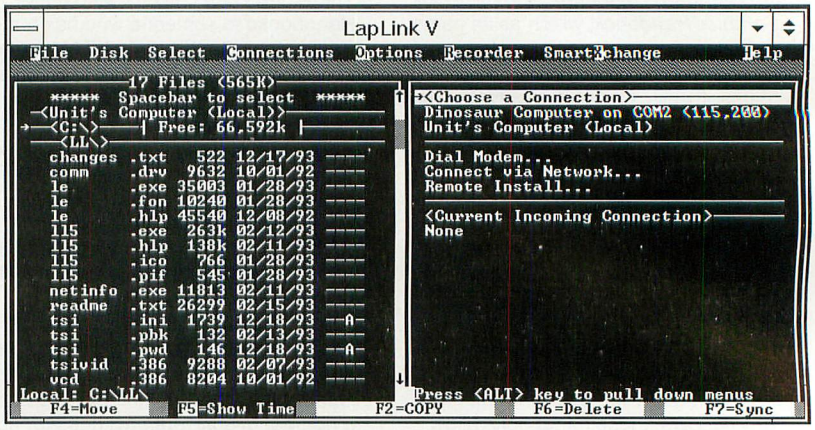


Fig. 1. Upon starting *LapLink*, this screen appears on the video monitors of both computers if both have *LapLink* running on them.

Beyond basic file transfers, *LapLink* V offers the possibility of many other uses, including but not limited to:

- Distribution of software updates to users
- Troubleshooting remote PCs by copying troublesome configuration files to a local PC, editing them and copying them back to the remote PC
- Setting up and configuring new PCs by using the program's built-in "Clone Drive" utility
- Tapping into central data from main offices, which can be useful for retrieving updated database files and spreadsheets and even updating workgroup schedules from a distance
- Viewing and editing local and remote files and running local programs without leaving the *LapLink* environment
- Performing file and directory maintenance on local and remote computers, including moving, copying, renaming, deleting and directory adding
- Setting up users' PCs to automatically back up data to floppy disks or a file server on a Novell network.

All in all, as you can see from the foregoing, *LapLink* V is quite a sophisticated package for file-transfer and other applications.

Leslee Jo Sebastian is the proprietor of PC Pinch Hitter, a desktop-publishing and PC consulting business.

Installation

You install *LapLink* to your hard disk via the product's Install routine. The installation procedure lets you choose a *Windows* installation so that *LapLink* is automatically optimized to run in the *Windows* background. You can also choose between Express and Custom installation. Express copies all files from the *LapLink* distribution disks to your hard drive and automatically changes your computer's PATH statement in your AUTOEXEC.BAT file. Custom gives you control over program configuration and file changes.

During installation, you're prompted for a name that's to be used to identify your system during transfers. Following the on-screen instructions is very straightforward, allowing you to complete installation in just minutes.

To make a cable connection, you must connect one of the included *LapLink* cables to the appropriate port on each computer. I chose a nine-pin (DB-9) serial connection for my two systems. According to the supplied documentation, parallel connections can be faster, but I encountered absolutely no problems with speed using the serial-port method.

For those of you who may be a bit shy when it comes to "port knowledge," Traveling Software has included in its *LapLink* V User's Guide full explanations on how to identify serial and parallel ports. The included cables even have SERIAL and PARALLEL stamped on them! This is a testament to Traveling Software's research into user needs.

Using It

To transfer files, *LapLink* must be running on both computers. Once it's running on one computer, you can install the software remotely over a serial cable or modem connection, using the Remote Install rou-

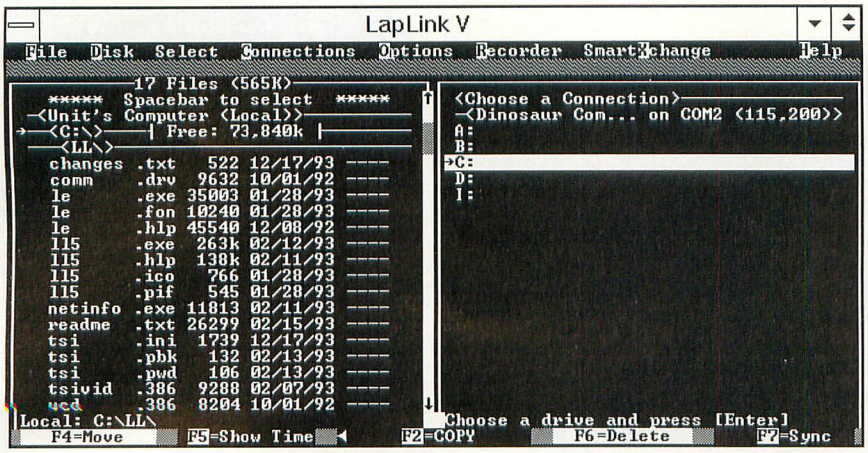


Fig. 2. A screen similar to this appears after you select the name of the target computer.

tine or simply by installing the system on the remote PC using the special supplied installation diskette. Remote Install is best for quick-and-dirty modem transfers. This method copies only LL5.EXE to the remote PC. Advanced features and the help system aren't transferred.

To start *LapLink* from the DOS prompt, you type LL5 and press Enter. If the PATH statement in your AUTOEXEC.BAT file doesn't have the *LapLink* directory included in it, you must change to the directory in which the program in installed. LL5 is the default here, though you can select another name if you wish during installation. To start *LapLink* in *Windows*, open the *LapLink* V group window by double-clicking its icon with your mouse. You'll note that the program's opening screen looks the same under *Windows* as it does under DOS. This is because *LapLink* V is a DOS-based program, with the *Windows* version running in a DOS window. Upon starting, the screen shown in Fig. 1 appears on both computers' video monitors if both PCs have *LapLink* running on them.

The left window in Fig. 1 represents the "local" computer, the one at which you're sitting. The right window represents the list of available connections. None have been chosen in Fig. 1, but it shows that Dinosaur Computer (Dinosaur Compu... on COM2 <115,200>) is available for connection, which is my old XT clone.

You can easily navigate the *LapLink* screen with your mouse, the Tab key or arrow keys. You can activate the menu bar at the top of the screen by pressing Alt plus the highlighted letter of the desired menu item or by clicking on your choice with your mouse. You can make menu selections with speed keys, highlighted with the arrow keys, followed by hitting Enter, or by clicking on it with your mouse.

Once two computers are connected to each other via *LapLink* V, copying and moving files are a breeze. The basic procedure is as follows:

(1) Specify where the file(s) will be copied or moved to by selecting a target drive and directory. You can change drives by highlighting the computer name and the hitting Enter. Either computer can send or receive files. A screen similar to that shown in Fig. 2 appears after you select the name of the target computer.

In Fig. 2, I've chosen Dinosaur Computer to be the target computer. I can now choose between its available A:, B:, C: and D: drives (I: is a Host Drive for a DoubleSpace drive C: in this computer) and directories. To choose a drive, highlight the drive letter and press Enter. In Fig. 3, you can see that I've selected drive C:.

(2) Select items to move or copy by moving the window that represents the source and navigate as above until you find the directories or/and files you wish to copy or move. There are several ways to make selection, but the most common is to highlight a file or directory and then press the space bar. Alterntatively, you can click on your selection with your mouse. Another alternative is to choose a command from the Select menu to make various kinds of selections. The Select All command, for example, selects everything in the directory. Selected items have an arrowhead (>) symbol to the left of them. In Fig. 4, I've chosen five *CorelDRAW* .CDR files to copy into the C:\ directory of the Dinosaur Computer.

There's a COPY button at the bottom of the screen that points to the target window. It's fairly easy to copy files to the wrong destination if you don't make sure that the arrowhead is pointing toward the correct one. The source window in which you've made your selections must remain highlighted.

(3) Press the F2 key to copy or the F4 key to move or mouse-click the COPY or MOVE button at the bottom of the screen. You'll see a dialog box that reports on the operation as it proceeds. You can also delete selected files by pressing the F6 function key or with a mouse-click on the DELETE button.

You can also copy and move files and directories by dragging with your mouse. To copy by dragging your mouse, first, point to a single item or group of selected items. Next, press your *right* mouse button and drag to the target window. Finally, release the right mouse button. This is about as simple and straightforward as an operation like this can be.

There are many ways in which you can customize *LapLink* to suit your particular needs. Among them are the following:

• **Copy Options** allow you to include or omit lower-level subdirectories, control file overwrite, New Files Only options and printed reports on *LapLink* activities.

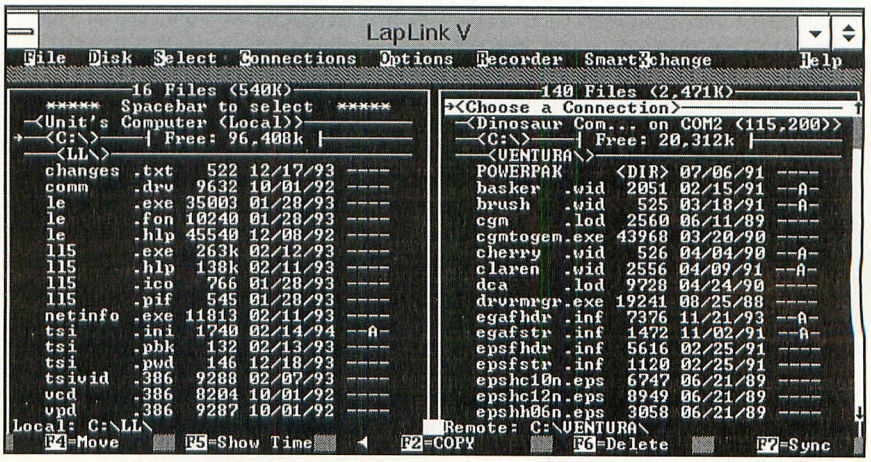


Fig. 3. You can now choose between the target computer's available A:, B:, C: and D: drives (I: is a Host Drive for a DoubleSpace drive C: in this computer) and directories. To choose a drive, highlight the drive letter and press Enter. Here you can see that I've selected drive C:.

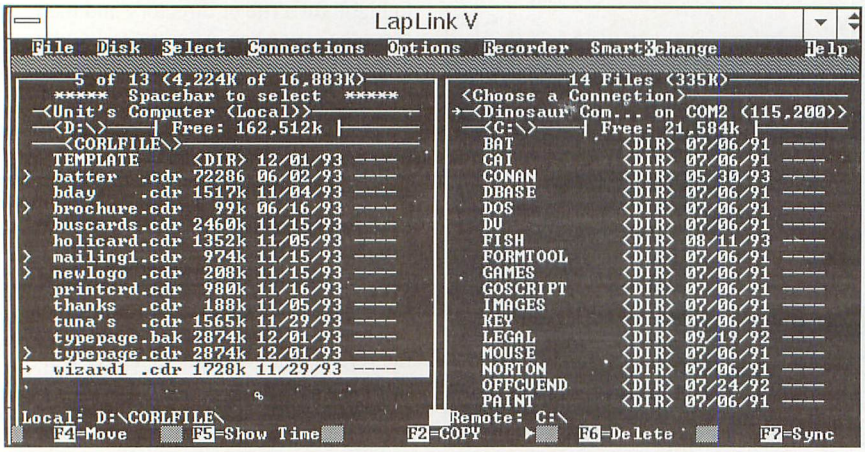


Fig. 4. In this screen, five *CorelDRAW* .CDR files have been chosen to copy into the C:\ directory of the Dinosaur Computer.

Product Reviewed

LapLink V; $169.95; $49.95 Software-Only Upgrade; $64.95 Software/Cable Upgrade
Traveling Software
18702 N. Creek Pkwy.
Bothell, WA 98011
Tel.: 206-483-8088

System Requirements: IBM PC/XT/AT or 100% compatible computer; 640K available user RAM; MS- or PC-DOS 3.1 or later or DR DOS 5 or 6. Mouse, Hayes-compatible modem and *Windows* 3.1, Novell *NetWare* 2.2 or 3.11 optional.

CIRCLE NO. 135 ON FREE INFORMATION CARD

Internet Watch By Alexander W. Burawa

Almost daily, the "information superhighway"—commonly referred to as the Internet—comes closer and closer to being a universal utility. Millions of computer users have already become regular travelers along its byways. As the system grows, it's certain to become mainstream—not just limited to computerists as it is now. Ushering in the future, products are streaming to market to inform you about the Internet through books and to get you started on your journey with other products that provide the means for connecting to the Internet. During the past several months, a host of new Internet book titles have been announced. To keep you informed of these, we offer the following mini-reviews and general listings.

From Waite Group Press...

Internet How-To: The Definitive Problem Solver
by Harry Henderson. *(Waite Group Press. Soft cover. 468 pages. $34.95.)*
This "problem-solver" book employs a "How do I..." question-and-answer format designed to help bring you quickly up to speed getting on-line and navigating the net. To make things easy to find, the book is divided into 15 chapters, each related to a specific topic, so that navigating this fairly hefty tome is relatively easy.

Internet How-To makes it easy to look up a specific problem and obtain step-by-step instructions to solve it. Plenty of real-life examples, explanations of why the techniques learned work and helpful hints and cautions are included.

The book begins with the foundations, such as using the Elm program to send and receive e-mail, reading the vast contents of the Usenet newsgroups and downloading software, graphics files and articles with FTP. It also tells you how to maneuver around the Internet's Relay Chat to talk with other netters in real-time. And a chapter on using Unix teaches you how to manage files in your home directory.

Once you know the basics, you learn more-powerful and sophisticated tools for unpacking compressed files, downloading and uploading files between your PC and the Internet using Kermit, working on remote systems with Telnet and Rlogin, locating resources by topic with Gopher and navigating the data highway with the interactive encyclopedia known as the World Wide Web. As a closing statement, this book provides a broad view of the possible strategies to Internet use and shows how to select the appropriate tool for a specific task.

Simple Internet by Jeffrey M. Cogswell. *(Soft cover. 162 pages. $16.95.)*
This book offers a unique approach to learning the Internet. Its detective-story parody leads you through the Internet in an amusing—and effective—fashion. Assuming the identity of detective Archie Finger, you unravel the mystery of the Simple Internet Connection. While immersed in the story, you'll: discover e-mail and how to use it; get information and take part in electronic discussions; transfer files using FTP and Gopher; log into databases; and ease onto the Internet without experiencing technical trauma.

Down-to-earth text and comic-book illustrations make your tour of the Internet with *Simple Internet* an amusing and easy-learn experience. In line with the somewhat amusing tenor of the rest of the book, most of its 14 chapters, have comic-book-like titles—A Message from Afar, Just the FAQs, Cool Things, Gopher It, to cite just a few.

(Continued on page 99)

- **File Display Options** permit file hiding, hidden and system file displays, sort alternatives and Show Matching Files Only options for local and remote computers.
- **Control Panel Options** let you to alter screen colors, mouse button functions, warning beeps, time and date formats and local computer names and to choose the *LapLink* editor or another one of your choice.
- **Security Options** in *LapLink* V permits greater latitude in setting up a security system to protect files from unauthorized access. You can specify who has access to your computer, which drives and directories to which they have access, whether they can overwrite or only read and copy and whether they must supply a proper password for any access at all. When setting up a security system, you can apply it to cable connections, as well as modem and network connections. A User List gives complete control over each individual's rights.
- **Automation** lets you automate tasks that must be performed on a routine basis with Recordings. These Recordings reduce the number of keystrokes needed to perform operations and can be scheduled for automatic playback, if desired.

User Comment

The supplied User's Guide is both well-written and informative. It provides general information, troubleshooting tips and error messages. A list of all *LapLink* files and their purposes is included so that the dreaded *Windows* Uninstall procedure can be performed without you having to go through a nervous breakdown.

The bottom line in this review of Traveling Software's *LapLink* V file-transfer package is that I'm glad I had the opportunity to run it through its paces. *LapLink* V will certainly remain an important part of my PC tool kit for years to come. I highly recommend it. ■

Hardware/Software Review **By SF Sparrow**

Installing SCSI Devices with Future Domain's PowerSCSI!

Some computer users would rather not pay a computer service to install a new CD-ROM drive. If you fit this category, you'd like to install it yourself but may be uncertain about the details of addressing, interrupts, DMA and device drivers. Fortunately for you, Future Domain recently introduced a flexible approach to the confusing mixture of SCSI devices and connectivity. Its product, PowerSCSI! and a SCSI Valuepak kit, comes with a SCSI adapter, software and cable.

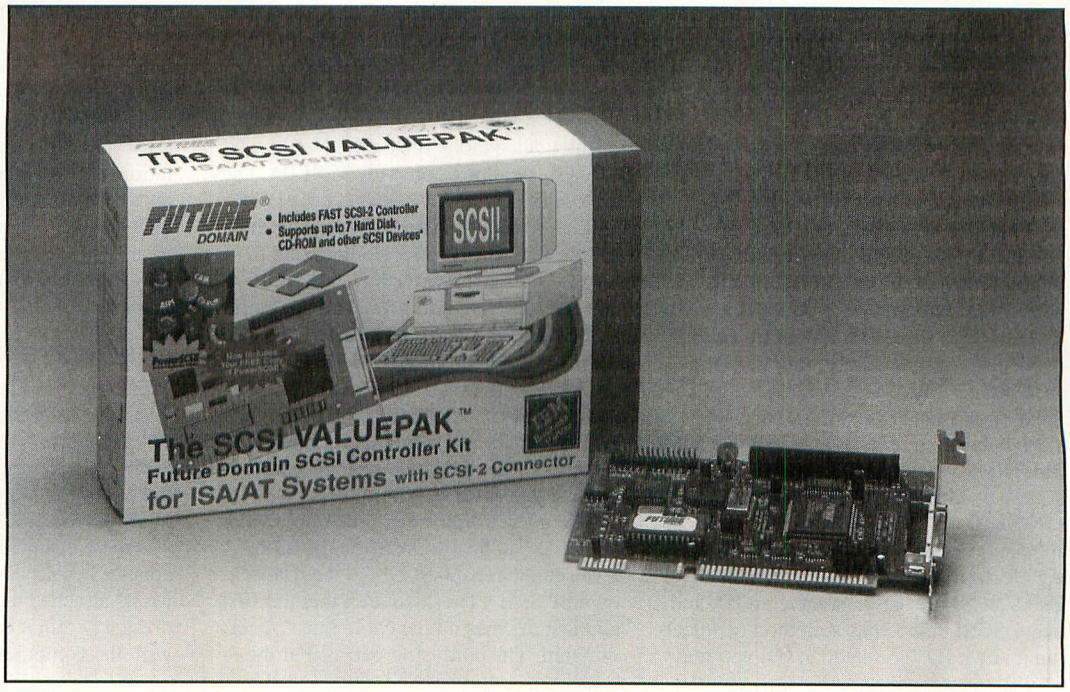
PowerSCSI! is flexible and easy-to-use system that traces its origins to the days of Future Domain's OEM Toolkit and Adaptec's ASPI (Advanced SCSI Programming Interface). Both interfaces did much to make it easier for developers to connect to a wider range of SCSI devices. Then appeared the CAM (Common-Access Method), introduced by the American National Standards Institute (ANSI). Today, CAM enjoys acceptance and support by such companies as NCR, Apple, IBM, DEC, Novell and Future Domain.

OEM Toolkit, ASPI and CAM were designed to bring SCSI devices closer to commonality, a result of the move toward a common interface-caused software incompatibilities because of special drivers written to control various peripheral devices. Microsoft's Interrupt 13 specification doesn't talk to Future Domain's OEM Toolkit, which doesn't speak to IBM's Interrupt 4B protocol, which can't work with Adaptec's ASPI, which doesn't speak ANSI's CAM, which doesn't understand Microsoft's Windisk, and so on. If this sounds confusing to you, imagine the frustration of developers who want to produce efficicent, low-cost products that everyone can use.

Future Domain responds to the conglomeration of software drivers by creating PowerSCSI!, a universal application interface that works with MS-DOS, Microsoft *Windows* and Novell *Netware*. PowerSCSI! permits software drivers written for any SCSI peripheral to be used with a single SCSI controller. The software system is, therefore, very close to true plug-and-play in capability for SCSI devices. A single SCSI host adapter can connect up to seven different SCSI devices and have all the right drivers automatically loaded during a normal installation procedure. It's an impressively intelligent approach, but it isn't quite plug-and-play. Users still have to determine and set SCSI ID for each device and account for proper termination of the SCSI bus.

PowerSCSI! is built on ANSI's CAM specification. The heart of PowerSCSI! is called Future/CAM. Starting with an operating environment, like DOS or *Windows*, you need device drivers to communicate with most SCSI peripherals. These drivers may run from CONFIG.SYS or AUTOEXEC.BAT. Typical examples are drivers for tape-backup systems, hard disks, CD-ROM drives, video or scanning equipment and drivers for removable media.

Future/CAM software sits between peripheral drivers and your host adapter. When an application makes a call for use of a particular SCSI perpherial, Future/CAM intercepts the call and converts the request into its own version of CAM. The part of the Future/CAM module that actually intercepts operat-



ing system calls is the Transport Layer, which figures out the protocol to use and passes it along to the proper interface module. In addtion, Future/CAM goes as far as reading a particular integrated circuit on an SCSI adapter so that it knows which device driver to use. The converted application call is then directed to the proper peripheral. Actual software-to-hardware techniques are quite involved, but the aim is to make it easier for users to install and manage SCSI devices.

Let's look at the concepts of installing a SCSI device, using Future Domain's PowerSCSI! system.

Preparation

The first step is to decide which equipment you need to buy. In this review, I use Future Domain's SCSI Valuepak for ISA/AT Systems. This Valupak comes with the model TMC-1680SVP SCSI-2 adapter. The 1680 is a 16-bit example of a modern high-speed adapter, the kind that SCSI users like. Unless you need a less-capable adapter for special reasons, you'd do well to buy the TMC-1680. It can satisfy all your present SCSI needs and take care of any future needs as well, thanks to its SCSI-2 interface. If you're not sure which adapter you want, a quick call to Future Domain will clear up the issue regarding what you need.

Before you get started, it's important to form a mental idea of what you intend to accomplish. Clear forethought means a better job of installation. Here are the tasks that must be completed for proper installation of a SCSI adapter and a SCSI device:

(1) Physically install the SCSI device in your computer if it's an internal model.

(2) Configure the SCSI adapter by setting its jumpers.

(3) Install the SCSI adapter in your computer.

(4) Connect the SCSI cable from SCSI adapter to SCSI device.

(5) Install the SCSI software.

Whatever SCSI device you buy should come with instructions for installation. An internal device, such as an internal SCSI hard drive or internal CD-ROM drive, can be mounted in one of your computer's drive bays, just as you'd mount a floppy-disk drive. This part of the installation consists mostly of securing your device in a drive bay so that it doesn't move around. But before you slide your new drive into a drive bay, check SCSI ID and termination.

• **SCSI ID.** SCSI ID is exactly what it appears to be: a way to assign an identifying electronic label to your new drive. Every SCSI device must have an ID, and every SCSI device has a method of selecting its own ID. To select an ID, you may have to adjust a number wheel, place jumpers on connector pins or set a DIP switch. The particular method for doing this depends on what the manufacturer of the particular device supplies. Its manual tells how to adjust the device. Sometimes, though, you have no need to change SCSI ID, unless you're installing more than one device on the SCSI adapter. If you're installing two or mor devices, you must make sure that no two of them have the same SCSI ID.

The SCSI specification states that you can have a total of eight devices connected to one SCSI cable. In reality, you have only seven because the SCSI adapter itself counts as one of the devices. Since eight devices are all you can chain together, the SCSI ID numbers range from 0 through 7, with SCSI adapter usually set as ID 7. So consider ID7 is already taken. SCSI IDs determine which device has greater priority on the SCSI bus, with ID7 getting highest priority. Your SCSI adapter needs the highest priority because it performs the job of managing the other SCSI devices.

• **Termination.** Related to SCSI ID is termination. A SCSI adapter and its attached devices form an electrical chain of components that are tied to each other via a common cable. SCSI specifications state that the first and last physical devices on the chain must be terminated. Keep in mind that this means the literal physical position of the device along the cable. Don't confuse physical position with SCSI ID. They are *not* the same.

Termination is a way of ensuring that all the signals that pass along the SCSI bus are free from distortion. By contrast, any devices that aren't first or last on the SCSI cable shouldn't be terminated. This is why it's a good idea to have the SCSI adapter as the first device on your SCSI chain. A SCSI adapter usually comes with built-in termination, and its traditional spot is first on the chain so that it has highest priority.

The matter of physical position *versus* SCSI ID can be a source of confusion. I've seen that each SCSI device has its own SCSI ID. I've also seen that the first and last devices on the cable must be terminated. The confusing part is that the physical location of a SCSI device has little to do with its SCSI ID, and SCSI devices don't have to be in any particular order. For example, you could have a new CD-ROM drive occupy a physical spot second in line from your SCSI adapter and yet might assign it any SCSI ID from 0 through 6. (Remember, ID7 belongs to the SCSI adapter.)

Taking this idea further, you could put two CD-ROM drives on your SCSI chain. Let's say that one drive is at the beginning and the other drive is at the end of your SCSI cable. This being the case, your SCSI adapter must sit in the middle. In this case, you'd terminate both drives because they're the first and last physical devices. However, you'd remove termination from the SCSI adapter because it's no longer first or last in the chain. This a perfectly acceptable configuration.

You could assign your drives any SCSI ID from 0 through 6. (Let your adapter keep ID7.) Such a scenario is common when installing both internal and external drives on the same SCSI chain. The SCSI adapter is forced into a middle position simply because of its location inside your computer, while the location of the external drive dictates that it has to be either first or last.

All this SCSI talk is to help you understand some of the basics. If you already have SCSI devices in your computer, you must pay particular attention to the installation. If this is the first SCSI device to be installed in your computer, you may not have to worry about any of this because your SCSI adapter and SCSI device are likely already set correctly straight out of the box.

Table 1. Address/Interrupt/DMA Map of Author's Computer System

Name	Function	Address	Interrupt	DMA
COM1	Modem	3F8	IRQ 4	None
COM2	Serial 2	2F8	IRQ 3	None
LPT1	Printer	378	IRQ 5	None
LPT2	Not Used	278	IRQ 7	None
SBlaster	Sound	220	IRQ 7	DMA 1
Joystick	Games	512	None	None

Hardware Installation

Thinking ahead applies to adapter installation, too. A SCSI adapter needs its own unique address, interrupt and, possibly, DMA. An address is necessary because the computer must communicate with all of its devices, including any SCSI devices you have installed. Because the SCSI adapter acts as communications manager for its attached devices, it has its own address wherein it exchanges information with the computer's processor. A SCSI

```
DEVICE=C:\DOS\EMM386.EXE RAM
2048 FRAME=E000
DEVICEHIGH=C:\MCAM18XX.SYS
DEVICEHIGH=C:\INT4BCAM.SYS
DEVICEHIGH=C:\ASPIFCAM.SYS
DEVICEHIGH=C:\FDCD.SYS
/D:MSCD0001
```

Fig. 1. CD-ROM driver arrangement author used to obtain maximum use of memory.

adapter can use one of several addresses, but it usually has a preset value called its default. The default address for the Future Domain TMC-1680 is 140. This is a good choice because it puts the adapter out of the way of almost everything else.

Knowing the address of a particular device is important. You may wonder how the processor knows when one of its devices wants to communicate. The answer is by use of an Interrupt. The device signals the processor by activating an electronic interrupt. The processor stops what it's doing, attends to the interrupt and then continues with what it was doing. The SCSI adapter does a special job for all attached SCSI devices because it controls which device communicates with the processor and when communication occurs. This is why you can have several SCSI devices but need only one adapter to control them.

Many devices, both SCSI and non-SCSI, use interrupts. The TMC-1680 defaults to Interrupt 5. Like an address, no two devices can use the same interrupt at the same time. Check sound cards and parallel printers to make sure that IRQ5 isn't taken.

If you have doubts about what address and interrupt to use, it may be that you aren't sure about the devices already installed in your computer. You can gather helpful information by using a diagnostic utility like *Norton Utilities*, *PC Tools* or *CheckIt* to learn which addresses and interrupts are in use by devices already in your computer. If you don't have a fancy diagnostic utility, you may already have Microsoft Diagnostics (MSD).

MSD comes with DOS 6.0 and later. Run MSD directly from the DOS prompt. The items to look at are to the right of your screen: LPT Ports, COM Ports and IRQ Status. LPT Ports gives the address of any parallel ports in your computer. Parallel ports are often referred to as printer ports. COM Ports gives the address of any serial devices in your computer, like COM1 and COM2.

IRQ Status is the important item because it lists all of your computer's interrupts and indicates which of them are in use. When looking for used interrupts, remember that internal modems normally use COM1 or COM2 at INT4 or INT3. MSD won't identify the existence of an internal modem, but it will mark the interrupt as in use.

If the IRQ numbers look confusing, scan the column labeled "Detected." Any IRQ marked "Yes" or that reports other information in the Detected column is an interrupt that's already in use. If you need to change your SCSI adapter to a different interrupt, feel free to do so.

Using diagnostic utilities and your user manuals, you can build a list of devices and associated addresses, interrupts and DMAs. Table 1 is an example of interrupt, address and DMA usage for my computer system. It tells me that the default INT5 of the TMC-1680 isn't good for my system because it's in use by parallel port LPT1. A better choice for interrupt is INT11.

The 1680's default address of 140 is perfectly fine and won't conflict with existing equipment. You may have noticed that my chart indicates a potential conflict between my Sound Blaster card and parallel port LPT2. Your keen eyes are correct, except for the fact that LPT2 isn't installed. This is why Table 1 notes it as Not Used. This chart also leaves out values for my floppy- and hard-drive controller because most devices steer clear of such well-defined areas.

Address and interrupt are enough for a SCSI adapter to exchange information with your computer, not counting the software, of course. Of nearly equal importance is the rate at which information goes from SCSI device to processor. Normally, the processor governs transfer of all information passed back and forth among all its devices. In some cases, there's a much faster method of data transfer in which the processor permits a controlling device to bypass normal communication channels and send data directly to memory. This technique is called Direct Memory Access, or DMA.

Interestingly, the 1680 doesn't use DMA. Hence, you don't have to worry about it. Future Domain reports that its SCSI adapters are just as speedy as other adapters that use DMA and points to an array of benchmarks to prove it. In my own use of the 1680, I found it just as responsive as comparable SCSI adapters; and I'm quite gratified to get by without using DMA.

```
LH C:\MOUSE
LH C:\VVESA
LH C:\CORELCDX.COM /D:MSCD0001
/M:30
LH C:\DOS\SMARTDRV.EXE A- B- C 1024
```

Fig. 2. A portion of author's AUTOEXEC-.BAT file that shows entries relevant to TMC-1680 installation.

One more thing needs attention before dropping the 1680 into your computer. This particular adapter comes with a built-in floppy-drive controller. If you already have a working computer system, you already have a working floppy drive as well. Therefore, you must disable the floppy controller on the 1680 so that it doesn't conflict with your existing floppy controller.

Final Checks

Once you're ready to install your SCSI adapter and devices, make sure your computer is turned off before removing the cover of the system unit. If yours is an internally-mounted device, secure it in a drive bay. If you have an externally-mounted drive, just place it on your computer desktop within easy cable reach.

Install the SCSI adapter in any free 16-bit slot on your computer's motherboard. Tighten it down before going any further. Next, connect the SCSI cable from the SCSI adapter to the CD-ROM drive. If you have an internal drive, note that the cable connectors are keyed so that they can't plug in the wrong way. There's a little rectangular bump on the cable connector and a matching notch on the receiving end of the adapter and drive. This bump-and-notch combination serves as a simple but effective interlock that prevents erroneous connection. If you're installing an external drive, just plug the cable into the back of the adapter and into the back of the SCSI device. Note that since the 1680 has a fast SCSI-2 connector on its rear, you must be sure that your SCSI device can accomodate SCSI-2.

Leave the cover off your system unit for now, just in case you need to make some other adjustments.

BIOS Talk

Before turning on the power to your computer, you should think about software installation and BIOS. The purpose of the SCSI utility software is to program the SCSI adapter and load the software drivers needed to access SCSI devices. This is where the intelligence of PowerSCSI! and Future/CAM can help.

You've no doubt heard of the acronym "BIOS," which stands for Basic Input/Output System. The BIOS is a small component, usually a ROM, in your computer that keeps track of what devices are attached to your computer, such as hard drives, floppy drives, video card, memory, etc. All these devices are called DOS devices because the BIOS knows about them and tells DOS how to use them. Unfortunately, your BIOS doesn't know about SCSI devices and can't see them at all.

To overcome this obstacle, a SCSI adapter has its own BIOS that picks up where your normal BIOS leaves off. The SCSI BIOS can read and identify any attached SCSI devices. If so programmed, it further can run tests and even configure the SCSI adapter. In the case of the 1680, you don't need the BIOS unless you're installing a boot device, like a SCSI hard drive that will be drive C:. If you already have a bootable hard drive, you can disable the SCSI BIOS so that you don't have to worry about it taking up conventional memory space.

Software Installation

The SCSI Valuepak comes with software for networks, DOS and *Windows*. Find the floppy disk labeled "For DOS/Windows/Netware 386." This is the install disk you need first. The installation routine asks if you want to use Express or Custom mode. Express mode reads your attached SCSI devices and automatically modifies your CONFIG.SYS and AUTOEXEC.BAT files to load the correct drivers. Custom mode does the same thing, but it prompts you for preferences on interface parameters. Don't use Custom mode unless you know the difference between single-tasking and multi-tasking CAM, and whether or not you shoud use 32-bit Windisk. Once the software is installed, reboot your computer and observe carefully to see if your SCSI device drivers load properly. If they don't, you'll see some kind of error messages and maybe hear some warning beeps from your computer. Upon successful installation, one remaining issue remains to be considered: memory management. This has little to do with the installation of your SCSI device, but it needs mentioning. Although PowerSCSI! automatically chooses the correct drivers and modifies your configuration files, you may not like the arrangement selected. Since I didn't, I rearranged them for maximum use of memory. The arrangement of my CD-ROM drivers is shown in Fig. 1.

MCAM18XX.SYS is the single-tasking CAM driver for use with the TMC-1680 host adapter. INTB4CAM.SYS converts all DOS standard INTB4 calls to CAM format. ASPIFCAM.SYS does the same for calls to ASPI. FDCD.SYS is the Future/CAM support for CD-ROM.

My AUTOEXEC.BAT file looks like that shown in Fig. 2. The item of concern here is CORELCDX.COM, the CD-ROM Extensions driver by Corel that takes the place of Microsoft's MSCDEX.EXE. The Corel driver is used in conjunction with the provided Corel utility software that scans the SCSI bus, interrogates SCSI devices and then displays detailed status of each device. An interesting note about the Corel CD driver is that this particular version (1.01d) doesn't work with *Myst*, a new Broderbund CD-ROM game that has just moved from the MacIntosh to the MS-DOS platform. If you wan't to run *Myst* with CORELDX.COM, you need to get the latest version of the driver. Otherwise, Version 2.20 or later of Microsoft's MSCDEX will hold you in good stead for running *Myst*.

The above examples shown in Fig. 1 and Fig. 2 are pared-down versions of my CONFIG.SYS and AUTOEXEC.BAT files. They're shown here reduced just to illustrate a working order for Future Domain's device drivers.

Product Reviewed

TMC-1680SVP SCSI Valupak (includes PowerSCSI!), $169; PoswrSCSI! software only, $79
Future Domain
2801 McGraw Ave.
Irvine CA 92714
Tel.: 714-253-0400

CIRCLE NO. 152 ON FREE INFORMATION CARD

Windows Utilities

PowerSCSI! does automatic installation for *Windows* just as well as it does for DOS. So there isn't much to worry about. The SCSI Valupak includes three other *Windows* utilities. One is the Corel utility mentioned above. The other two are an image display and organizing utility called *ImagePals* and an audio CD player and organizer named *Animotion*. *ImagePals* and *Animotion* are demonstration copies and, thus, are restricted in function. You are urged to purchase the full versions.

User Comments

Installing a SCSI adapter and devices isn't a small task for first-timers. Next time, you may be able to take advantage of the software and hardware plug-and-play movement now afoot, of which Future Domain is a member. This system promises to rid the the computing world of jumpers, DIP switches and thumbwheels. Until then, remember the important items: address, interrupts, DMA (if used), termination and device drivers. As long as you understand how to handle these issues, you can install any SCSI device. ■

By Tom Benford

Multimedia

Great Products For Multimedia

This time out, I'll be giving you a closer look—and listen—to some great products for multimedia, including a fantastic new General MIDI tone generator from Yamaha, superb studio-quality stereo headphones from Audio-Technica, four-source merging module from MIDI Solutions, sophisticated yet easy-to-use multimedia presentation package from Q/Media and the intriguing *Windows Animation Festival* book/CD-ROM combination from the Waite Group Press.

Stereo Headphones

In my last column, I covered Audio-Technica's ATH-P5 Omniphones stereo headphones that, at $29.95 list, represent one of the better values for private multimedia listening. But as good as the ATH-P5s are, they're not top-of-the-line studio-reference listening devices, nor were they intended to be. For professional applications that demand the frequency response and pristine sound reproduction that only full-ear headphones can deliver, the $109.95 ATH-910 Dynamic Stereophones from Audio-Technica are the answer.

Everything about the ATH-910 is first-rate, from the inside on out. Before I get into the technical specifications of these great headphones, the first issue I want to address is comfort. In the more that 1,500 hours it took to compose, record and mix my album, *Some Things I've Done*, I became more of an expert on the comfort of headphones for extended use than I ever hoped to be. Believe me, this isn't an issue to be taken lightly if you'll be spending any amount of time wearing them. The main comfort factors are the weight of the headphones and the amount of pressure they exert on your ears. You want as little of each as possible.

These closed-back, fully enclosed dynamic headphones weigh in at only 205 grams (less than 8 ounces) and exert a total ear pressure of only 250 grams. I prefer the closed-back design, which fully eliminates any ambient room noise, but Audio-Technica also offers the model ATH-911, which is the open-back counterpart of the 910s. The light weight and low ear pressure of the 910s enable you to keep them on for extended stretches that span hours without feeling like you have a phone book on top of your head with your ears and temples in a vise. The large comfortable ear pads provide a soft fit while sealing your ears into a virtual sound chamber, and they're easily replaceable.

The large-diameter drivers measure 44 mm and utilize Samarium-cobalt magnets, with a 16μ diaphragm. The voice coils are copper-clad aluminum wire, and they boast 92-dB sensitivity. The frequency response of the ATH-910s is rated at 20 Hz to 22 kHz, and impedance is a nominal 600 ohms. The curled-type cord is 3 meters in length and is terminated with a standard 6.3-mm stereo plug.

Adjusting the ATH-910s for a comfortable fit is easy, thanks to a click-stop mechanism built into the headband. The slide holder retains your adjustment until you intentionally change it again. So the headphones always fit just the way you like them whenever you put them on. Left and right ear orientation is color-coded, using gray and red, respectively.

Audio-Technica's ATH-910 Dynamic Stereophones are ideal for multimedia production work, as well as for general stereo listening. These phones are ultra-light in weight and low in pressure for comfort, yet they deliver a full dynamic range of 20 Hz to 22 kHz, with brilliant clarity.

Hence, you always get the correct audio perspective.

If you're producing multimedia, doing .WAV file or sound-effects mixes, creating MIDI music or just about any other serious audio application, the ATH-910s are definitely the way to go. And when you're

done working with your PC, you can always plug the phones into your home stereo system and listen to your favorite sounds with brilliant clarity and response. So you can have the best of both worlds.

Tone Generator

Wow! was my eloquent utterance when I heard Yamaha's TG300 for the first time, and it's a word that describes many aspects of this General MIDI-compliant device. *Wow* is justified with respect to its features, sound, flexibility and overall usefulness, and even though I've used this nifty unit for several months now, I'm still discovering new sounds, features and uses for it that continue elicit *wows* on a fairly regular basis. How many devices have you encountered that you can say that for?

This little black box has so much packed into it that its difficult to know where to begin. So let me start by giving you a fast overview of what it offers.

The TG300 is the latest addition to Yamaha's TG series of tone generators, packing 456 high-quality voices, nine drum kits and an FX (effects) collection into a compact 10 1/8" x 8 5/8" x 3 5/8" unit that weighs less than 4.5 lb. The TG300's sound architecture employs AWM2 (Yamaha's second-generation Advanced Wave Memory) with digital filters, and it stores 195 sound waves in its massive 6M of ROM. The acoustic instrument voices, as well as exceptional synth textures, are robust and full of ambient "presence," thanks to the unit's 16-bit CD-quality processing.

All of the TG300's voice elements consist of one or two sound elements, and the unit provides extensive editing capabilities, with independent envelope and scaling controls for pitch, filter and level that permit you to create your own unique voice patches.

One of the nicest features of the TG300 is its ability to provide 32-note polyphony with 16-part multi-timbrality. So you literally have the instruments of a 16-member orchestra (you pick the 16 instruments) at your command. All of the parts and voices are fully editable. Sound parameters include filter cutoff and resonance, level envelope generator, portamento, MIDI control change assign and MIDI bank select support.

The TG300's MultiMode is ideal for multi-track MIDI sequencing. It totally eliminates the need for any other external synthesizer for scores or projects that will require a maximum of 32 notes at any one time. Of course, you could always add another TG300 or any other MIDI device by daisychaining if you so desire.

SingleMode, on the other hand, is designed for live performances It provides

Yamaha's TG300 Tone Generator is literally a full orchestra, sound-effects studio and digital signal processor, sound synthesizer and stereo mixing console, all in one compact unit. It's General MIDI-compliant and even has its own built-in MIDI interface for direct connection to a PC or Mac serial port. A back-lit 21-character, eight-line LCD display and easy-to-use editing controls permit virtually unlimited sonic tailoring and creation of custom patches.

128 editable internal voices with assignable effects, which makes it ideal for use with MIDI keyboards and synthesizers. Note and velocity range parameters allow for split, layer and velocity crossover type voices.

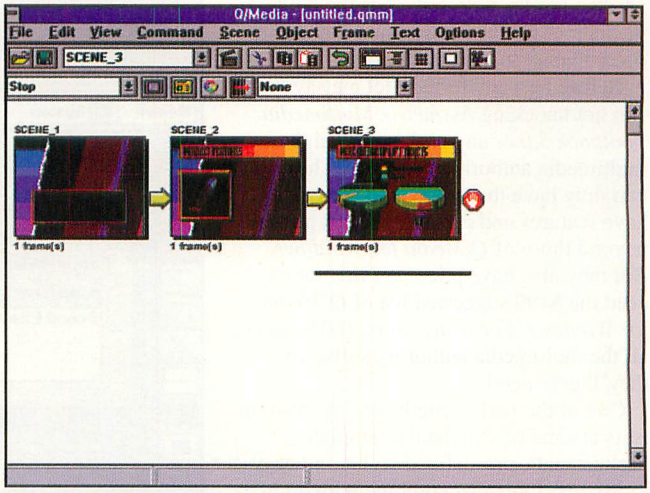
The effects capabilities of the TG300 deserve a big *wow* by themselves. Yamaha's custom DSP (digital signal processor) provides a full spectrum of reverb, chorus and variation effects simultaneously. The unit can deliver a whole host of effect algorithms, including reverb, chorus, flanger, EQ, rotary speaker and Aural Exciter, which allow you to add spaciousness, stereo depth and "sparkle" with an unlimited amount of control.

Effect types and controls consist of distortion, EQ, chorus, flanger, echo, cross delay, symphonic, rotary speaker, tremolo, auto pan, phaser, pitch change, auto wah, exciter, compressor, reverb (Hall, Room1, Room2, Room3, Stage1, Stage2, Plate, WH Room, Tunnel, Canyon, Basement), early reflections (ER1, ER2) and gate reverb. The TG300 is powered by a 700-mA 12-volt ac adapter, which is supplied with the unit, and the audio connections include 1/4" phone jacks for right and left mono line out, two phono jacks for left and right audio in, and a 1/4" stereo jack for headphones. The MIDI connections are all standard five-pin DIN jacks for MIDI IN, MIDI OUT and THRU.

The TG300 conforms to the General MIDI standards and permits playback of third-party MIDI songs and song data exchange with other musicians. As well as standard MIDI jacks, a built-in MIDI interface permits direct connection to the serial port of your PC (or Macintosh, for that matter), eliminating the need of an ex-

By keeping it small, light and simple, MIDI Solutions' Quadra Merge makes an ideal traveling companion for the mobile musician or multimedia user who needs to merge multiple MIDI input sources for a single merged MIDI output.

The user interface of *Q/Media for Windows* is simple and straightforward, utilizing familiar tool and drop-down menus to access its many features and functions. The program permits integrating all multimedia elements—text, graphics, video, sound and music—easily and coherently, using drag-and-drop techniques.



By breaking every step of a multimedia presentation into an individual scene, even the most complex and ambitious presentations are manageable for the average user. Again, using the drag-and-drop metaphor, completed scenes are assembled in the desired order.

ternal MIDI box or internal/external MIDI interface. An eight-pin mini DIN jack is provided for connecting the TG300 to the host PC.

The user's manual supplied with the unit is complete in every respect, although some of the more advanced and esoteric functions involved in creating new patches may require several readings to fully comprehend. The variable bank selections of the unit also provide compatibility with software designed to work (or take advantage of the controls) of Roland synths and sound modules.

Sound from the TG300 is lush to the point that words don't accurately describe it. You literally have to hear this unit to appreciate how good it sounds. If you're looking for a General MIDI tone generator that does so much more than any other comparable unit and leaves everything else in the dust in terms of sound quality, the TG300 is the object of your quest.

MIDI Merging Module

MIDI Solutions is a company that continues to provide exactly what its name suggests—innovative solutions for today's musician. Once the digital domain of only performing and recording musicians, MIDI has been made accessible to virtually everyone using *Windows* and for those of us who are "pushing the multimedia envelope." MIDI Solutions' products are truly a boon.

The latest offering from the company is its new Quadra Merge four-input MIDI Merger. As with the other MIDI module products in the company's line, Quadra Merge is powered by the MIDI signal and requires no battery or power supply to operate.

Quadra Merge measures approximately 4½" x 2½" x 1¼" and weighs about 5 oz., making it small and light enough to conveniently tote along in a "gig" bag or in a notebook case. Five standard DIN jacks provide I/O connections, four of them for input and the fifth for MIDI output.

The function of Quadra Merge is simply to merge four MIDI input sources into a single output source. While this sounds like a straightforward task, getting it to work correctly takes a bit of doing. MIDI solutions has succeeded in producing a unit that can handle all types of MIDI data—including System Exclusive and MIDI Time Code messages—smoothly and without a glitch.

To use Quadra Merge, you merely connect its inputs to the MIDI OUT or THRU jacks of the sending MIDI devices, using standard MIDI cables. The MIDI OUT on Quadra Merge is then connected to the MIDI IN of the receiving MIDI device. If you have need to merge more than four MIDI input sources, you can connect together other mergers for as many inputs as required. If you daisychain, the MIDI OUT of the first Quadra Merge connects to one of the MIDI IN ports of the second Quadra Merge, and so on until the final connection is the MIDI OUT of the last Quadra Merge to the MIDI IN of the receiving device.

A MIDI indicator LED built into the unit lights up as soon as the device connected to MIDI IN #1 is turned on. The LED flashes whenever MIDI data is passing through the unit to provide a good visual monitor of the MIDI data transmission.

Though it probably won't be required by most users, Quadra Merge comes with a thorough 11-page mini user's manual.

An extra-special bonus included with Quadra Merge is a free introductory membership to CompuServe that includes one month of free access to all of CompuServe's basic services and a $15 introductory usage credit to explore the MIDI Vendor Forum and other services. You can also GO MIDISOLUTIONS and get technical support, download new-product announcements and information and provide feedback on products and recommendations for new products once you're on-line.

If you're getting into MIDI in a big way and have multiple devices to be merged, Quadra Merge is a most useful—and functional—tool.

Multimedia Authoring

Lots of PC users are interested in exploring multimedia but feel the skills and knowledge required to effectively merge text, graphics, video, sound and music may be beyond their capabilities. The solution here is to harness the power of the computer to do the actual work of bringing things all together, thereby letting the user attend to the creative end of the production. This is precisely what *Q/Media* 2.02 from Q/Media Software does.

Using the software is basically a matter of dragging and dropping the elements you want to use in the order in which you want them to appear. To afford control, you also drag and drop, activating such devices as buttons, bars and hot links that, when accessed, cause actions (such as playing a video segment) to occur. The

product has been described as the multimedia tool for the masses, and it does, indeed, live up to that moniker.

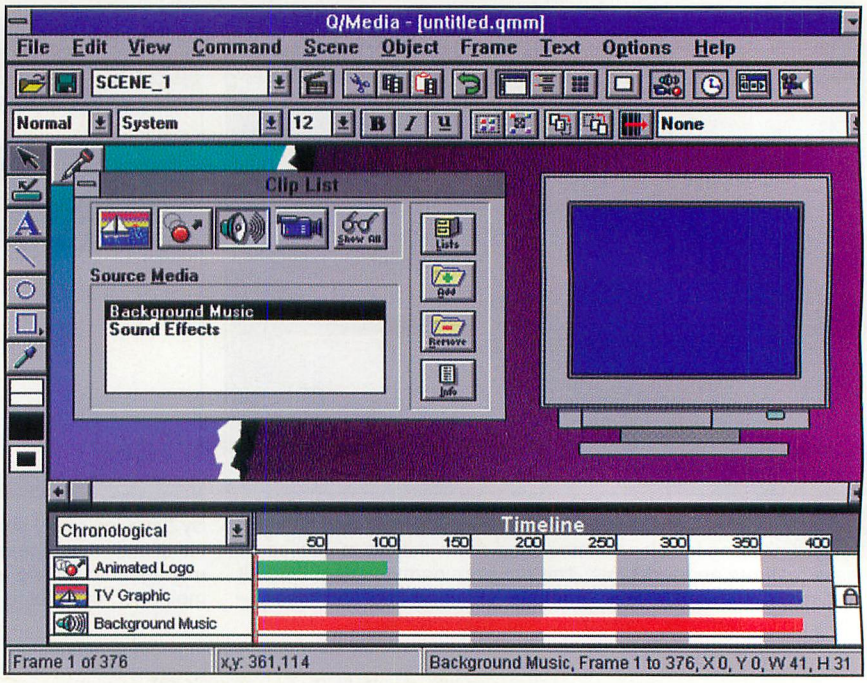
Before I go any further, let me say that I'm not knocking *Asymetrix Multimedia Toolbook 3.0* or any of the other high-end multimedia authoring packages. These certainly have their place and uses and have features and capabilities that go way beyond those of *Q/Media for Windows*. But they also have price tags that far exceed the $199 suggested list of *Q/Media for Windows*. For many users, *Q/Media* is all the multimedia authoring software they'll ever need.

One of the real strengths of the program is its arsenal of clip media, templates, backgrounds, pre-defined styles and easy-to-use text tools that combine with an intuitive outliner that makes it very easy to put together multimedia presentations, even for a total multimedia novice. What's really surprising, however, is how "slick" these presentations look using these canned goodies. You get all of the sparkle with none of the sweat!

Q/Media for Windows provides a nicely integrated set of text and drawing tools for creating elements directly within the program itself. A text editor supports user-defined styles that aids you in maintaining a consistent, professional look throughout your presentation. The integrated drawing tools are excellent for creating diagrams and charts. More than 20 different transitions and effects are also provided for drawing and text objects, and automatic alignment, and sizing of the objects makes putting everything in its place a snap, if you'll excuse the play on words here. One of the nicest visual features is the program's ability to produce truly stunning and very dramatic effects using multi-color gradient backgrounds.

The program supports elements created with other popular applications, including OLE 2.0 conformity so that you can drag-and-drop from other applications as well. You can add animation from *Autodesk Animator*, *3D Studio*, *Animation Works Interactive* or any other .FLC- or .FLI0-compatible animation program and play multiple animations simultaneously. Audio support for WAVE, MIDI, RIFF MIDI or CD Audio files is included, and you can synchronize the audio with images, animation or video.

Image support for .BMP, .WMF, .DIB, .PCX, TARGA, TIFF, .EPS, .GIF, .WPG, JPEG, .DCX and PICT files is provided as well as the ability to integrate Kodak Photo-CD imagery. *Microsoft Video for Windows* (.AVI) and *QuickTime for Windows* (.MOV) files are supported. and support is provided for the Intel/IBM DVI Card (.AVS) and MPEG (.MPG). Thus, using one of the popular video overlay



Elements of the production are called into play by using a time line to achieve precise synchronization. Like all other aspects of the *Q/Media for Windows* program, the interface is highly intuitive with a shallow learning curve.

cards, you can drag-and-drop video onto the screen from your LaserDisc, VCR or camcorder by doing a video segment capture from within the program itself.

Q/Media's Quick Link navigation facilitates fast creation of interactive branching to scenes, other applications, control of embedded objects, displaying messages and triggering MCI events. The included automatic button tool with six button styles, including 3D and transparent buttons, makes adding good-looking interactive controls simple and quick as well.

An extra bonus is inclusion of a CD-ROM that contains 500M of royalty-free clip media. This disc contains scores of video, .BMP, .WAV, animation and other files you can use as desired in your productions. This disc is a worthwhile resource that makes the *Q/Media for Windows* package the super value it is and the most-affordable way to produce high-quality multimedia presentations I've seen to date.

Animation Festival

Computer animation, created using Cray supercomputers, was once limited to the resources of NASA, other government-funded agencies, Hollywood studios and well-heeled corporations. But with today's 486, Pentium and RISC-based PCs, the realm of creative CGI (computer generated imagery) has opened up to the average user interested in delving into this fast-emerging artform.

A new book/CD-ROM combination from the Waite Group Press written by Alberto Menache and Richard Sher showcases the cream of the 3D movie crop, and it's now showing on a PC near you.

Packed with more than 120 computer-generated flics, the *Windows Animation Festival* CD literally transforms your multimedia computer into a virtual cineplex, complete with sophisticated special effects, incredible hues and designs and full-blow sound and music.

The motif of the disc is divided into six interactive theaters (they carry this metaphor through with walk-throughs of the lobbies, etc.). In each of the theaters you'll view a different area of computer animation: the dancing appliances and foods in Broadcast and Commercial animation; the visualization of artificial comets and dueling insects in Scientific and Educational Animation; tomorrow's cities and infrastructures in Industrial and Architectural Animation; the fantastic creatures—ferocious dragons, shimmying snowmen, even Elvis—in Computer Animation Art; the courtroom re-creations of auto accidents in Legal Animation; and an underground theater featuring a potpourri of the authors' computer animation pieces, from the human brain to deep space satellites.

The 112-page soft-cover book that accompanies the CD-ROM includes a brief overview and introduction to Autodesk *3D Studio*, one of the most capable and popular applications for creating computer animations. It then describes the minimum

Products Mentioned

Audio-Technica ATH-910 Dynamic Stereophones, $109.95
Audio-Technica U.S.
1221 Commerce Dr.
Stow, Ohio 44224
Tel.: 216-686-2600

CIRCLE NO. 130 ON FREE INFORMATION CARD

Yamaha TG300 Tone Generator, $895
Yamaha Corp. of America
6600 Orangethrope Ave.
PO Box 6600
Buena Park, CA 90622-6600
Tel.: 714-522-9011

CIRCLE NO. 131 ON FREE INFORMATION CARD

Quadra Merge Four-Input MIDI Merging Module, $129
MIDI Solutions Inc.
816-810 W. Bway.
Vancouver, BC, Canada V5Z 4C9
Tel.: 604-794-3013

CIRCLE NO. 132 ON FREE INFORMATION CARD

Q/Media 2.02 for Windows, $199
Q/Media Software Corp.
312 E. Fifth Ave.
Vancouver, BC. Canada V5T 1H4
Tel.: 604-879-1190

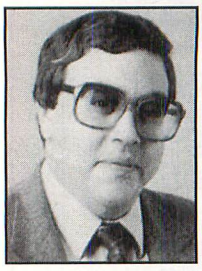
CIRCLE NO. 133 ON FREE INFORMATION CARD

Windows Animation Festival $32.95
(CD-ROM and Book)
Waite Group Press
200 Tamal Plaza
Corte Madera, CA 94925
Tel.: 800-368-9369

CIRCLE NO. 134 ON FREE INFORMATION CARD

requirements and installation procedures for getting the CD-ROM up and running on your PC. The rest of the book is devoted to providing information on the creators of each of the animations that appear on the disc, as well as inside production notes and details on what was involved in creating each.

This is by far one of the most impressive and entertaining CD-ROMs I've seen. It provides stunning examples of how far PC technology has come in just a few short years. The animations—each and every one of them—are absolutely first-rate, and the *Windows Animation Festival* CD is a must-have for anyone who is interested in CGI.

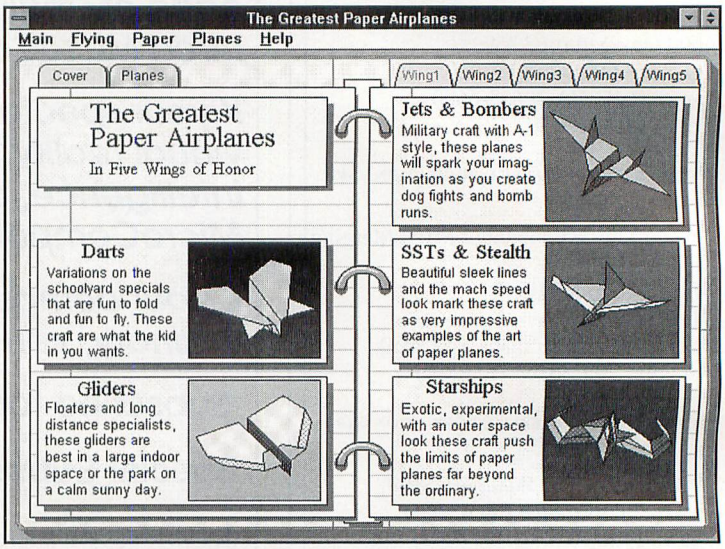


MicroComputer Musings By Ted Needleman

Making Paper Airplanes; Adding Emphasis to Any *Windows*-Based Application; Re-sizing and Re-Sampling Image Files; Having Fun Manipulating Images

I'm not quite sure whether it's the approaching signs of old age, or just the result of having four children under the age of 10 in the house, but over the past two years or so, I find I'm spending more time "playing" on the PC than in all the years previous. Since I'm only in my late 40s, research for this column might be an even better "excuse." Regardless of the reason, I have to admit to spending more time enjoying my PC use.

Perhaps it's just that in the last couple of years, the software has gotten so good, with multimedia and enhanced graphics, that it has finally broken through my past high level of disinterest in non-business use of computers. In any case, here are a few of the fun and interesting things I've been spending my time with lately.



Each of these five categories in *The Greatest Paper Airplanes* offers five different airplane designs.

Flight 1 Now Boarding...

When I first received Kittyhawk Software's *The Greatest Paper Airplanes* package to look at, I did a little informal research. I asked a couple of dozen people in my office if they knew how to make a paper airplane. Every one of them did! And it was always the same one. I wasn't able to find anyone who didn't learn how to fold a paper airplane as a child. And every one of them could still do it! I won't say that there aren't a few people here and there who never learned how to fold a paper airplane, but I'd hazard a guess that most of us learned this crucial skill early in life.

I really don't need to go into great detail about mankind's fascination with flight. It's been extensively detailed over the centuries in all sorts of media, going back to mythology. Perhaps that's why we all enjoy taking a flat sheet of paper and folding it into a shape that can soar and travel fairly great distances. Kittyhawk Software (named after the place in North Carolina where Orville and Wilbur first took to the air) has leveraged on this by creating a *Windows*-based program that not only prints out folding diagrams for 25 different paper airplanes, but it also takes you step-by-step through the process of creating them.

As with most *Windows* applications these days, installing the software is just a matter of swapping disks when asked. After installation is finished, running the software brings up the image of a tabbed spiral-bound notebook. There are sections on "Flying," "Paper," and "Planes". The Flying section covers some of the history and principles behind heavier-than-air flight, while the Paper section likewise provides background on the history and production of paper. All of the sections, including the Planes section, make good use of multimedia. Clicking on highlighted words produces animations and sounds.

Finally, there's the Planes section. This is subdivided into five subsections, each of which contains five similar plane designs. Between the 25 planes, designs vary from simple to complex, from the ubiquitous Dart to way-out stealth and starship planes. Included with the package is a pad with all of the designs pre-printed on its pages. This lets you use the software even on a PC that's not connected to a printer.

I found using the software a lot of fun. You first select a design with which to work. Then you move to the printing screen, where you can select the designs that will be printed on your plane. You can't use your own graphics, but you can choose between military and decorative. These designs can be printed out as solid (actually shaded) graphics or as out-

lines that can be colored in with marker pens later. Your planes print out with different colored designs if a color printer is attached to your PC. You can also print the folding lines for either the top or bottom (or both if you feed the paper through the printer twice) and add extensive text instructions.

Once your plane has been printed, it's time to fold it. Here's where the software really shines. The folding screen takes you through the entire folding process one step at a time. The display is animated, and you can "play" the entire folding sequence straight through as a movie or watch how each fold is performed. Do it, and go onto the next fold. With some of the more-complex paper planes, this is about the only way you can keep up.

The Greatest Paper Airplanes is available in both the 25-plane retail version I received for $49 and a shareware version that's available on many BBS systems. The shareware version has just a few designs, and it doesn't come with the preprinted pad of designs or the large reference card that serves as the software's printed documentation. But it's a great way to see if you like the software.

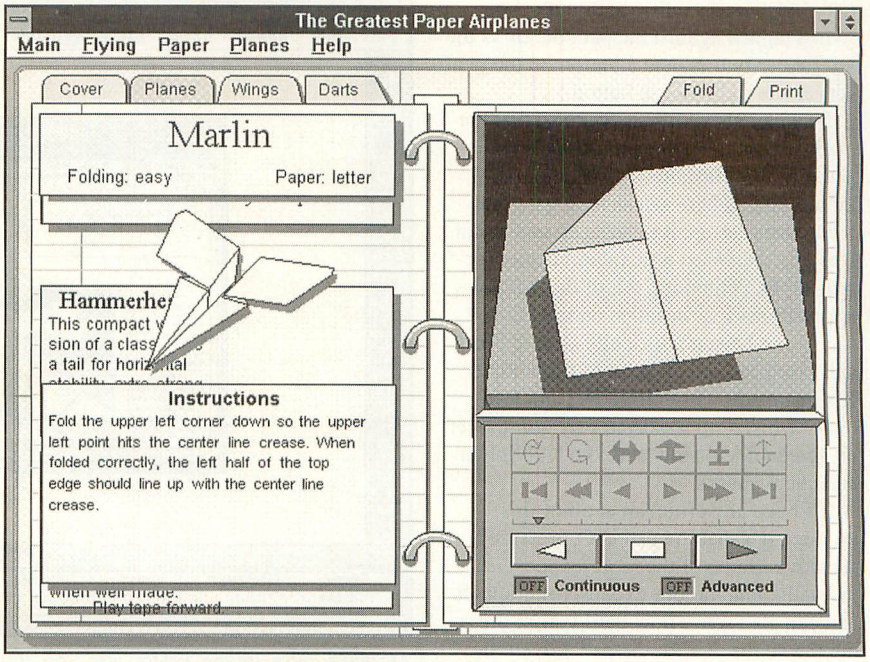
Kittyhawk's *Greatest Paper Airplanes* is appropriate for many age groups, but the more-complex designs gave nine-year-old Marc (and me, for that matter) a lot of trouble. However, he and eight-year-old Bryan and Scotty enjoyed making and folding the simpler designs. I wouldn't recommend the program for anyone younger, unless you're going to do the work. Karin, who is six years old, was completely baffled by the program but liked watching the rest of us make airplanes. She does, however, enjoy flying our masterpieces.

When you're not printing and folding paper airplanes, you can watch the included screen saver, which presents the folding animations in place of your blank screen. Kittyhawk flies straight and true with this one.

Pass the (Electronic) Pencil

Consumer Technology Northwest is best known for its video products. Its *Presenter Plus* series of scan converters let you easily and inexpensively display your PC's output on standard TV receivers. The Electronic Marker Pad represents a significant, and well-executed departure from the vendor's normal type of product.

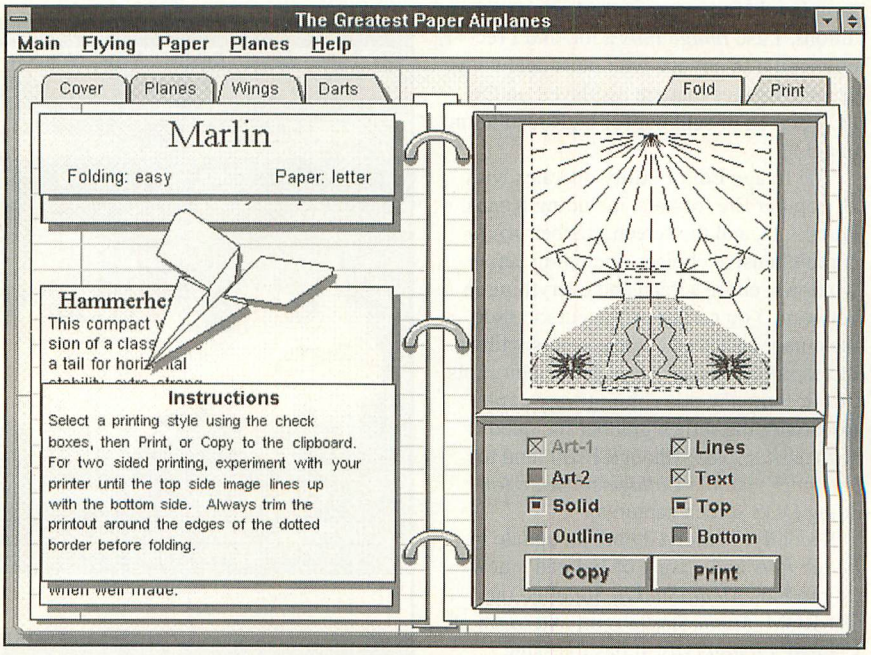
The core of this product is software. In fact, the *Electronic Marker* software was first available without the pad, and is still sold that way for both *Windows* and the Mac. But even without the graphics pad, it's still a very useful utility.



When you click on the right "play" arrow in *The Greatest Paper Airplanes*, an animation sequence takes you step-by-step through folding your plane.

Conceptually, *Electronic Marker* is a simple product. It lets you add emphasis to any *Windows*-based application in the form of graphics like checkmarks, colored underlines or even yellow or blue highlighting. You can accomplish this with either your mouse or, if you purchase the marker pad, with the included wireless pen. Then, whenever this "marked-up" screen is called up, it displays with the included graphic objects. Your application will, however, still print normally.

Installation took me about 5 minutes, which included connecting the graphics pad, a Kurta Penmouse, to my second serial port. The Penpad provides a 4" X 5" sensing area, and the wireless pen, which is detected when it's within a 1/2" of the



The "Print" screen in *The Greatest Paper Airplanes* lets you select the options you want before sending your design to your printer.

pad, functions as a two-button mouse (when tapped against the pad, the tip is the left mouse button, and a button on the pen acts as the right mouse button.)

You can install the software so that the mark-up uses only the mouse, only the pad or both. I installed it so that both mouse and pad are active. Software that recognizes a graphics pad, such as Fractal Designs' *Dabbler*, will automatically recognize the Penmouse. All of the *Windows* applications I've installed on my PC seemed to have no difficulty with the pad, and I've been having a lot of fun with it. It's installed on my office PC, and I've really wowed my associates by going over on-screen documents with the highlighter and check marks.

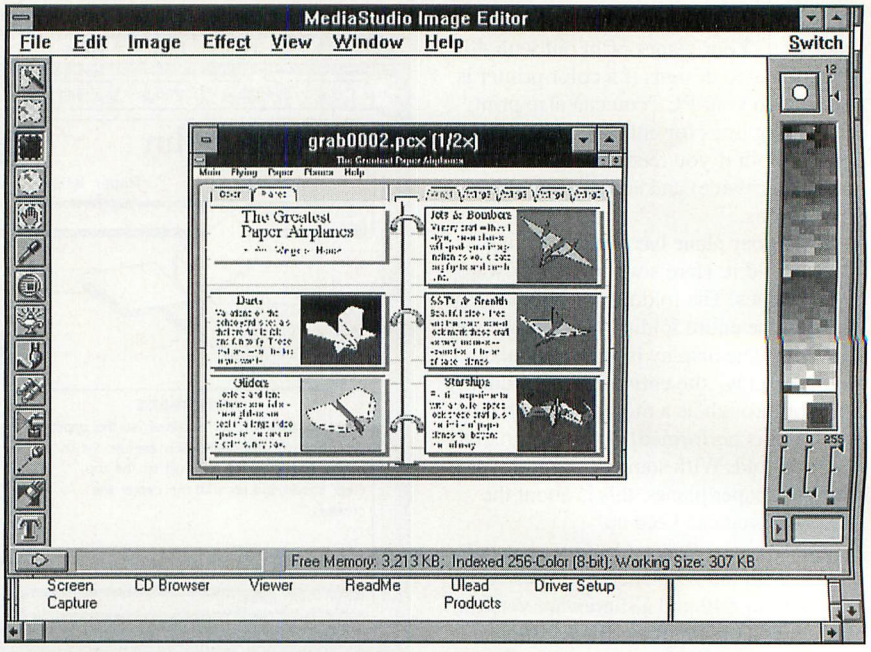
If I have any criticism at all of this product, it's that the pad isn't pressure sensitive. Some of the more-expensive (actually, *much* more-expensive) graphics pad can also sense how hard you're pressing the stylus against the pad. Given the very attractive price of this product, though, you're getting an awful lot for your money.

It Dices, It Slices....

U-Lead Systems is a company you're probably not familiar with, unless you use Aldus *PhotoStyler*, which U-Lead wrote. I've been using the company's *ImagePals* package for about a year to grab *Windows* screens and manipulate them before sending the files out to have slides made from them. *Image Pals* is one of the few packages I've run across that lets you both re-size an image file and, if you wish, re-sample it between screen and printer resolutions. I use *Image Pals* a lot, and I recommend it to anyone who must deal with graphic images that are displayed on the PC's screen or sent out for high-resolution imaging.

The Image Editor utility operates with all popular file formats, including Kodak Photo-CD, and the screen grabber offers comprehensive choices, including active windows, entire screen and everything in between. You can show the cursor, hide the cursor and even change colors within the captured image. All of the screen shots that accompany this column were captured with the screen grabber included with *MediaStudio* (though I still tend to use inner vision's *Collage* software for doing DOS screen captures).

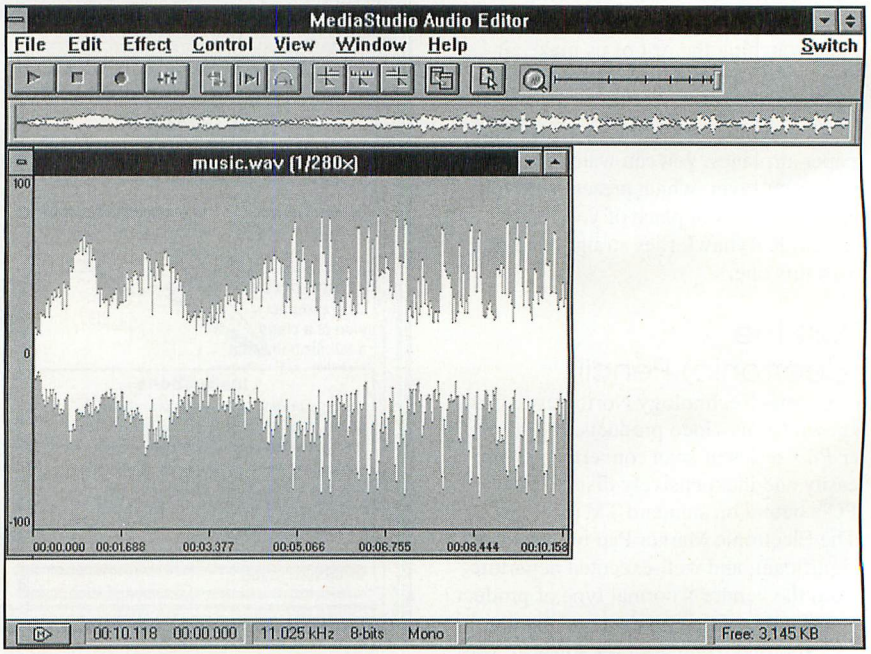
Recently, I received both an update to *Image Pals* and a copy of U-Lead's newest product, *MediaStudio*. Supplied on CD-ROM, *MediaStudio* is an extension of U-Lead's *ImagePals*. It has the same screen-capture function, and the image editor and album functions appear identical



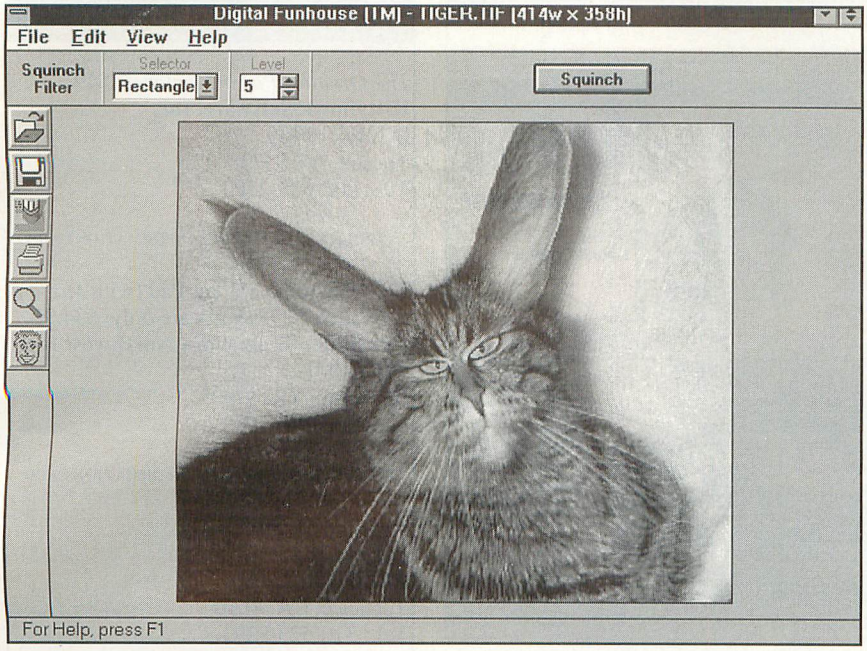
MediaStudio's Image Editor lets you re-size, re-sample and perform many other operations on an image file.

to those contained in *ImagePals*. The Album function, by the way, lets you collect sets of images into logically grouped "albums." You can easily view thumbnails of these collections through the Album function, making it easy to organize, locate and load just the image for which you're searching.

Where *MediaStudio* differs from *ImagePals*, though, is in the addition of products that let you capture and edit video, a .WAV file audio editor, and a Morph Editor that lets you take two graphic files and morph them into a third file. A bonus, installed from the CD-ROM, is a set of audio utilities that are similar to those "rack-mounted" utilities that accompany most multimedia upgrade kits these days. These utilities include an audio CD player, a mixer and a recorder. Except for these "bonus" programs, each of the major software utilities in *MediaStudio* (Image



MediaStudio's Audio Editor lets you easily modify .WAV files.



Tiger the cat, after being subjected to *Digital Funhouse*'s Squinch effect.

Editor, Video Editor & Capture, Morph Editor, etc.) has its own small manual. This makes it pretty easy to find answers when you're using a specific module, but I'm certain that I'll eventually lose a couple of these manuals. Of course, if everything had been put into one large manual, I'd eventually lose that as well.

I don't have a video-capture card installed in my PC at the moment, so I didn't have a chance to test out the Video Editor & Capture module, but I did try out the others. As with my old "pal" *ImagePals*, I found all of U-Lead's utilities exceptionally intuitive and very easy to both learn and operate. Except for entertaining the kids, I doubt whether I'll be using the Morph Editor all that much, but I do anticipate that the rest of these utilities will fast become favorites, as has *ImagePals*.

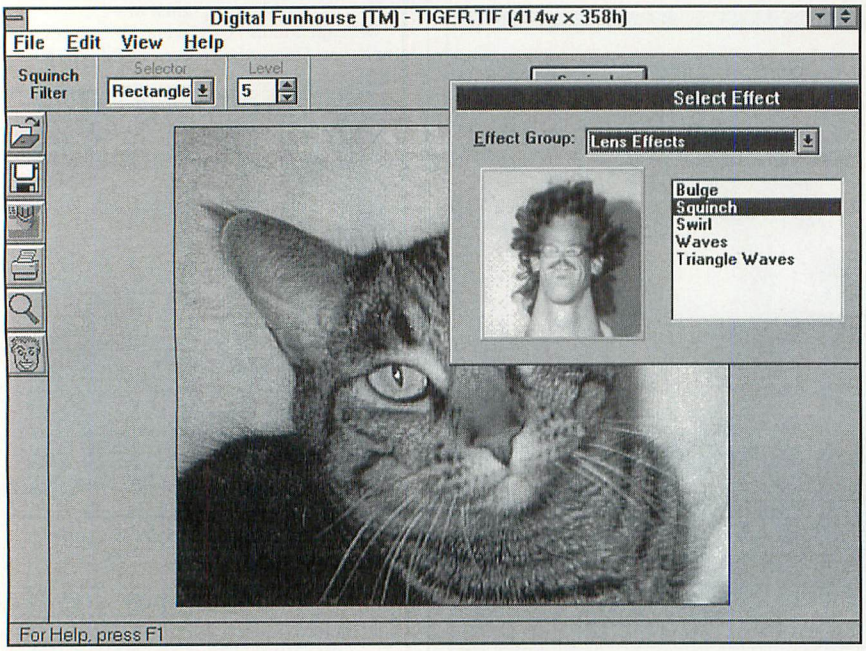
MediaStudio is provided on a CD-ROM, which contains plenty of sample image files and sound files for you to experiment (and learn the software) with. My only complaint is that the installation process requires that you enter the serial number. I almost always misplace this before starting to install software, and I can't tell how annoying I find it when software requires me stop what I'm doing and start searching for a registration card with the required number. U-Lead, and other vendors who do this, should take a lead from Micrografx, which asks for the serial number but allows installation to proceed even if you don't enter it. I've recently taken to copying the number onto a label, stuck to the second disk with a product that installs from floppies, or the case of a CD-ROM-based product. This way, when I need to reinstall it (I frequently wipe software from my overcrowded hard disk and reinstall it at a later time, when I actually write about it), the number is right there if I need it.

Other than the foregoing small annoyance, I really like what U-Lead has done with this product. And although the $349 suggested list price is a little steep when compared to *Picture Publisher* and *PhotoShop*, *MediaStudio* has a lot of different capabilities that these other programs don't. It's a tool you should definitely have if you do anything with digital images.

A Nip Here, a Tuck There

While I'm on the subject of graphics software, I'll tell you about a product that's been developed to capitalize just on the fun side of image manipulation. This isn't to say you can't use for business, but at less than $80, I don't see it blowing *PhotoShop* and *Picture Publisher* out of the market, even though it's a lot easier to use.

Ease of use is *Digital Funhouse*'s biggest selling point. Just open up an image file, the software supports a variety of popular formats. including TIFF, .PCX, CompuServe .GIF, and Windows' Bitmap among others. Since *Funhouse* uses only 256-level grayscale or 24-bit color format, if the file isn't already in one of these forms, the software converts it. Scanners using the TWAIN standard are also supported by the software. You can scan directly into *Digital Funhouse* by using the



Digital Funhouse lets you easily apply a variety of effects to any graphics file.

Acquire command. Once you've loaded the file with which you want to work, just start experimenting.

Just like many other graphics packages, *Digital Funhouse* can flip and/or rotate an image and perform a number of image-improving operations like color and tone correction, sharpening and removing spots from a scanned image. Where the software really shines, though, is in the special effects you can apply with the click of a mouse button. These include lens effects (bulge, squint, swirl, wave and triangle wave), diffusion effects (stipple, raggedy, melt and blur), stretching, sizing, mirrors, puzzles (tile, slice 'n' dice, circular, mosaic, kaleidoscope) and artistic (pencil drawing, oil painting, negative and pixelate.)

To be honest, there isn't much you can do in *Digital Funhouse* that you can't do in other software like *PhotoShop*, *Dabbler* and others. *Kai's Power Tools*, from hsc, and plug-ins from numerous other vendors provide all of these effects and many others as well. But the beauty of *Digital Funhouse* is that you can apply all these manipulations with just about zero learning curve. I don't know if this is the easiest graphics package I've ever used, but it certainly ranks up there if it isn't.

Digital Funhouse isn't really targeted to a kids' market. It's billed as a program for the whole family. But once my kids saw me playing with it, they insisted that I install it on their machines. And all of them have been having a ball playing with the effects, and printing the results on their color printers. Given my experience, I'd have to give *Digital Funhouse* a big thumbs up! ■

Products Mentioned

The Greatest Paper Airplanes, $49
Kittyhawk Software, Inc.
PO Box 64189
Tucson, AZ 85728
Tel.: 602-622-2200

CIRCLE NO. 126 ON FREE INFORMATION CARD

The Electronic Marker Pad (with *Markup* software), $295; Software only, $34.95
Consumer Technology Northwest Inc.
7853 SW Cirrus Dr.
Beaverton, OR 97005
Tel.: 800-356-3940

CIRCLE NO. 127 ON FREE INFORMATION CARD

MediaStudio, $349
U-Lead Systems
970 W.190 St., Ste. 520
Torrance, CA 90502
Tel.: 310-523-9393

CIRCLE NO. 128 ON FREE INFORMATION CARD

Digital Funhouse, $79.95
Symsoft
PO Box 10005
Incline Village at Lake Tahoe, NV 89450
Tel.: 702-832-4300

CIRCLE NO. 129 ON FREE INFORMATION CARD

By Joe Desposito

Computing On the Go

PCMCIA Is Headed For a Desktop Near You

When Jack Peterson of SCM Microsystems showed up at the *MicroComputer Journal* offices recently, he told Managing Editor Al Burawa and me about a new device that would soon be appearing in desktop PCs as a standard feature. It's a combination 3½" floppy-disk drive and Type II PCMCIA slot. The size of this combination unit is the same as a standard 3½" floppy drive. He didn't give us a combo unit to try out, but did give us a device called the SwapBox Classic X2.

SwapBox Classic X2, which sells for $199, is a PCMCIA Card reader/writer with two Type II PCMCIA slots. Since I already had a PCMCIA drive in my desktop system, I asked Jack about the advantages of SwapBox. He told me that SwapBox could do more than just read from and write to PCMCIA storage cards, such as the 10M SunDisk I use. SwapBox also works with such I/O cards as PCMCIA modems, sound cards, network cards, etc.

With the foregoing in mind, I removed the ProTege ATA/X unit and controller card from my system and replaced it with SwapBox and its controller card. The first thing I noticed about the new controller card was that it uses the Vadem PCMCIA controller chip. According to Jack, only Intel and Vadem controller chips are truly compatible with the PCMCIA standard. I also noticed that the controller card had no jumpers or switches that had to be set to configure it.

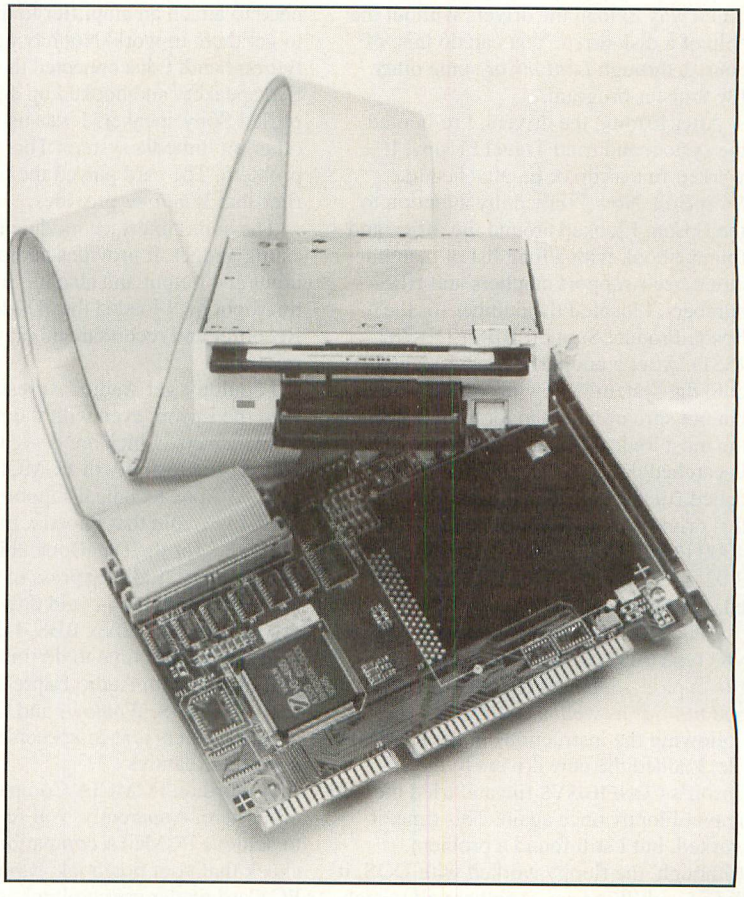
When I plugged the card into an available expansion slot on my PC's motherboard, I noticed something else. The controller card is approximately ¼" taller than the standard cards in my system. Additionally the cable connector faces upward! When I attached the cable, I found that it faces the wrong side of the computer. So I had to fold it over to reach the connector on SwapBox. I didn't put the system-unit cover back on, but if I had, it would have crunched down hard on the cable.

Though SwapBox has a 3½" form factor, SCM includes a 5¼" mounting bracket, which I used. After mounting SwapBox in a 5¼" drive bay and connecting it to the controller cable, I turned on the system and loaded the SystemSoft driver software.

With installation complete, I tried to use SwapBox. I placed the SunDisk in one of SwapBox's slots and tried to access it. Nothing happened. At this point, I called SCM's technical support. The person I spoke to told me that the card has a default I/O setting of 3E0, which conflicted with my scanner card. Once I removed the scanner card, SwapBox began to work as expected, reading from and writing to the SunDisk card. Unfortunately, the I/O setting of the SwapBox controller isn't only a default setting, but it's also hard-wired and can't be changed. Luckily, it's easy enough to change the I/O setting of my scanner card.

I was happy to see SwapBox working because I had two other PCMCIA products to review, neither of which worked with my Epson ActionNote 4000 and Hewlett-Packard OmniBook 300 subnotebook computers.

One of these PCMCIA products is Travel Floppy from Accurite Technologies, which comes with a PassportCard controller Type II PCMCIA card. This device, which sells for $249, seems like a good product to have on hand for a couple of reasons. One



SCM's SwapBox Classic X2 is a PCMCIA card reader/writer with two Type II PCMCIA slots and 3½" floppy-disk drive in a standard 5¼" drive form factor.

is that I figured it would be a help with the OmniBook, which doesn't have a floppy drive. The other is that I thought it could be useful with the Epson, which does have an external floppy but forces you to give up the printer port to use their floppy drive.

I found out, though, that Travel Floppy doesn't work with the OmniBook (the company is working on this), but it does support the smaller HP 100LX palmtop. Also, it didn't work with the Epson. One of the tech support guys at Accurite told me that the DataBook PCMCIA drivers on the ActionNote 4000 needed to be updated. Accurite gave me the number for DataBook, which I called and was referred to Epson. I called Epson technical support, only to find that the lines were busy, as usual. In the meantime, since I wanted to test Travel Floppy, I decided to use it with SwapBox on my desktop.

To install Travel Floppy, you plug the PassportCard into a PCMCIA slot and then attach the cable on Travel Floppy to the PassportCard. Unfortunately, you can't use the drive until you load the drivers onto your system. This was no problem for me, since my system already has a 3½" drive. If you're working with a subnotebook or palmtop, though, you must find a way to load the drivers without the help of a disk drive. You can do this, of course, through *LapLink* or some other file transfer program.

After loading the drivers, I re-booted the system and tried Travel Floppy. It worked fine as drive E:, attached to SwapBox. Now I turned my attention to the Epson. I looked around the office and found a book with a long list of manufacturers, tech-support numbers and BBS numbers. I located the number for the Epson Product Support BBS (310-782-4531). After a couple of tries, I logged onto the system. Knowing what I wanted, but not sure of where to look for it, I tried the most logical library—DRIVERS. Then I searched under "D" and found a file called DB302.EXE. The information on this driver was as follows: ActionNote 4000 PCMCIA Cardtalk Driver Version. 3.02. Since this was exactly what I wanted, I downloaded the file.

DB302.EXE is a compressed file. When you type DB302 at the DOS prompt, the file explodes a bunch of Cardtalk drivers and utilities as well as a README file. Following the instructions in the README file, I added the new drivers to the Epson's CONFIG.SYS file and tried the Travel Floppy once again. This time, it worked, but I still found a problem. Although, the floppy worked with DOS, it didn't with *Windows*. Another call to tech support gave me the answer. One of the Cardtalk drivers uses a switch for the memory area D000 through D7FF. If you don't block out this memory area, *Windows* overwrites it. According to the support person at Accurite, you can block out this area by adding the EMM386 device driver with an X switch to your CONFIG.SYS file. So I added the following statement:

```
DEVICE=EMM386.EXE RAM X=D000-D7FF
```

With this statement in the CONFIG.SYS file, Travel Floppy worked perfectly with the ActionNote 4000, both in DOS and *Windows*.

The next PCMCIA product I tried was the Audio Express 16-bit audio adapter from Apex Data that sells for $399. Included with the package is the PCMCIA audio card, an audio interface module, audio cable, un-amplified speakers and software. To install Audio Express, I slipped the audio card into SwapBox, attached the audio interface module to the card and loaded the drivers.

Since Apex doesn't provide any *Windows* utilities to play with Audio Express, I used the *Windows* Media Player to test the card. I attached the un-amplified speakers to the audio interface module, but no sound came out. Apparently, you need to attach an amplifier to the speakers to get them to work. Not having an amplifier on hand, I disconnected the un-amplified speakers and hooked up a pair of amplified Sony speakers I was using on another multimedia system. This solved the problem. The card played the few .WAV files that *Windows* provides.

The audio interface module is an interesting gadget. It provides audio jacks for input and output and also has a built-in microphone. I loaded the *Windows* Sound Recorder and recorded and played back my voice.

I couldn't get Audio Express to work with the Epson, even with the new DataBook drivers, which are designed work with a broad variety of PCMCIA cards. So I called Apex technical support to find out why. I was told that Phoenix makes a set of drivers for the DataBook chip that would allow Audio Express to work with the Epson and that I could download these drivers from the Apex BBS. I decided to wait for another time to do this.

Included with Audio Express is *Monologue* for DOS, *Windows* and OS/2. This program offers text-to-speech capabilities and other features.

A word on PCMCIA Compatibility is in order here. Apparently, you're more likely to achieve PCMCIA compatibility if you check that your notebook, subnotebook or PC Card reader uses an Intel or Vadem chipset. If it uses a DataBook or other chipset, you'll need to keep up with the latest driver updates to maintain compatibility.

Products Mentioned

SwapBox Classic X2, $199
SCM Microsystems
985 University Ave., Ste. 7
Los Gatos, CA 95030
Tel.: 408-395-9292; fax: 408-395-8782
CIRCLE NO. 154 ON FREE INFORMATION CARD

Travel Floppy and PassportCard, $249
Accurite Technologies, Inc.
231 Charcot Ave.
San Jose, CA 95131
Tel.: 408-433-1980; fax: 408-433-1716
CIRCLE NO. 155 ON FREE INFORMATION CARD

Apex Audio Express, $399
Apex Data, Inc.
6624 Owens Dr.
Pleasanton, CA 94588
Tel.: 510-416-5656; fax: 510-416-0909
CIRCLE NO. 156 ON FREE INFORMATION CARD

XM-4100A CD ROM Drive, $415
Toshiba America Information Systems, Inc.
Disk Products Div.
9740 Irvine Blvd.
Irvine, CA 92718
Tel.: 714-583-3000; fax: 714-583-3437
CIRCLE NO. 157 ON FREE INFORMATION CARD

New Toshiba CD-ROM Drive

When I received Toshiba's new XM-4100A CD-ROM drive, I was a bit confused as to why it came with an eight-bit SCSI card. At a feather-light weight of 1.2 lb., I expected to see a PCMCIA SCSI controller bundled with the package. A call to Toshiba's PR agency straightened things out. The XM-4100A's suggested retail price of $415 doesn't include the controller. If you want to connect it to your notebook, you must provide the PCMCIA SCSI controller yourself. Fair enough. At least I was sent a controller to check out operation of the drive.

Specifications of the drive include 320-ms average access and 300K/s data-transfer rate, which are typical of double-speed drives. The design and weight of the unit, though, are its most-attractive features.

The clamshell design of the XM-4100A makes it look and feel just like an audio CD player. You can use it as such, too, since it has an earphone jack, play/stop button and volume control. There's no battery operation, though. You need to plug in the included ac adapter.

On the back of the drive is a standard SCSI connector, SCSI ID dial and a couple of DIP switches. A test switch lets you change between normal CD-ROM and CD-audio player mode. A parity switch turns on or off parity.

To use the drive, all I had to do was plug the SCSI card into my desktop machine, load some software and connect a cable from the XM-4100A to the card. This I did, but the SCSI drivers wouldn't load. I am becoming adept at using the PAUSE key to find out why the heck drivers in my CONFIG.SYS file won't load. Hit PAUSE to stop, any other key to start, I keep saying to myself.

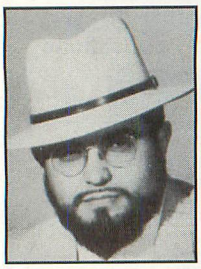
At this point, I didn't have many other boards left in my PC. I'd pulled the scanner and network cards to get SwapBox to work. So the only cards left were the SwapBox controller, VGA card and an internal modem. I pulled the SwapBox card, put a REM in front of all the SystemSoft drivers in my CONFIG.SYS file and tried again. Still, the SCSI drivers wouldn't load. As a last resort, I decided to run the Microsoft Diagnostics (MSD) program included with MS-DOS 6.2.

The default address of the SCSI card is CA00:0000, which is set by four jumpers. This address, which resides in what Microsoft defines as upper memory (the 384K of memory above your computer's 640K of conventional memory), isn't to be confused with an I/O port address nor an interrupt setting. I took a look at this area of memory with MSD and found that the area from C800 to CBFF (16 blocks) was occupied by two shaded blocks and 14 U blocks.

Figuring that the sequence goes something like C800, C900, CA00, CB00, it looked like there were U blocks starting at CA00. These U blocks are used UMBs (upper memory blocks). Therefore, the SCSI drivers couldn't load at this address. I looked at the memory map and found some blank blocks at address DE00, which corresponded to one of the jumper settings on the SCSI card. I set the jumpers on the card to DE00 and put the card back into my computer. Now it worked.

Toshiba provided a disk called *Nautilus*, which is a collection of shareware games, images, .WAV and MIDI files and other information. I placed it in the XM-4100A and roamed around the disc trying as many items as I could. With the Apex Audio Express installed, I was able to play all the .WAV files on the disc. Everything worked well.

With its light weight and slim design, Toshiba's XM-4100A certainly makes a case for taking a CD-ROM drive on the road with you or for shuffling it around the office for use on a variety of PCs.



By Yacco

GUI Guts

Losing it With File Manager

Like knowing the paths that cut across a field or wind through back streets, familiarity with its shortcut keys gives you a major advantage when using an application. It's essential to have them in a graphical environment once you've learned an application and no longer need to rely on those exasperatingly slow multi-level menus. But keystrokes aren't always the best solution.

Windows has it's dangers, of course. You'll want to be sure that those shortcut keys don't have you moving so fast you overlook them. For example: What does the *Windows* File Manager do when you copy a file to a write-protected diskette? It lets you think it's making the copy, even though it's not doing so.

One solution is to check the write-protect tab before you put a diskette in the machine or to yank the diskette out if it's already in the machine. The best procedure, though, is to maximize your use of the graphical interface. Always open directory windows for both source and target diskettes so you can check to see if the file appears after it's written. As long as you have those windows open, just use the mouse to drag and drop your files This is one of the things the graphical interface can do more quickly than shortcuts, especially for multiple-file copies and moves.

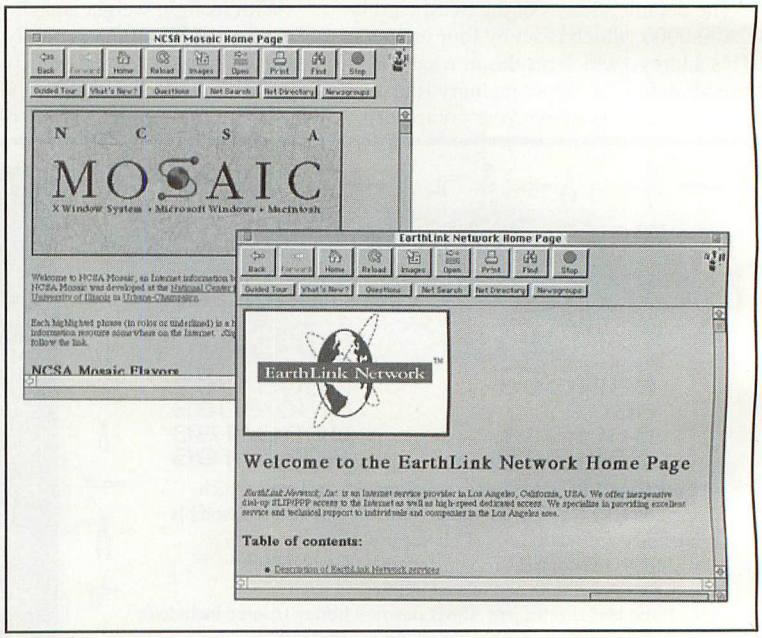
If you insist on using keystrokes and your machine isn't conveniently close by, there's a way to check the tab without walking over and pulling a diskette that's already in the drive. First, check your Options menu and make sure the Delete box is checked. Don't omit this first step. Then, delete any file on the target diskette. If the tab isn't set, *Windows* will alert you. If the tab is set to write, you can stop deletion using the confirmation dialog.

Copying files with keystrokes is just one example of how the habits you learned with DOS can lead to using *Windows* in a less-than-efficient way. Another, even more egregious, habit is to continue using DOS for file management. File Manager's little quirks and drawbacks might make DOS seem tempting, particularly if you're a long-time master of DOS. However, if you open File Manager and use it properly, you can save a lot of time.

One of the things that wastes a lot of time in DOS is moving between directories. File Manager lets you open separate windows for up to 23 directories, even on different drives. There are several ways to manage them. With a moderate number of open windows, you can cascade or tile them. This lets you see some of the contents. If there are too many directories to see any of the contents, you can iconize them all. This lets you see all the directory names, but it requires you to click on an icon before you can work with the directory.

Cascaded and tiled directory windows are very convenient when working with small directories. If there aren't too many directories, you can see all files at one time. When you work with many directories or large ones, fully maximizing tiled windows or cascading directory windows lets you see more files and helps you be more efficient.

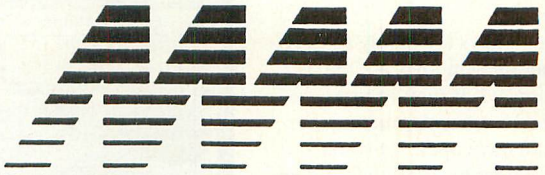
You can use several methods to move between windows. Clicking on icons or open windows is one choice, but this requires you to close one window before you can open another (in the case of icons), or to have all your open windows small enough to share the video monitor's screen. Here's where key-



Through an Internet provider, such as EarthLink, Inc., in Los Angeles, you can use such tools as Mosaic NetScape (pictured here) to navigate the Internet.

strokes can give you the upper hand.

Using the Ctrl-Tab (or Ctrl-F6) keys is much faster than opening and closing windows. This keystroke sequence lets you scroll forward though your directory windows the same way Alt-Esc scrolls though your program windows and DOS sessions. It would be nice if Ctrl-Tab could switch back and forth between two directory windows like Alt-Tab does between your two most-recent application windows, but it doesn't. Instead, you can use Shift-Ctrl-Tab to



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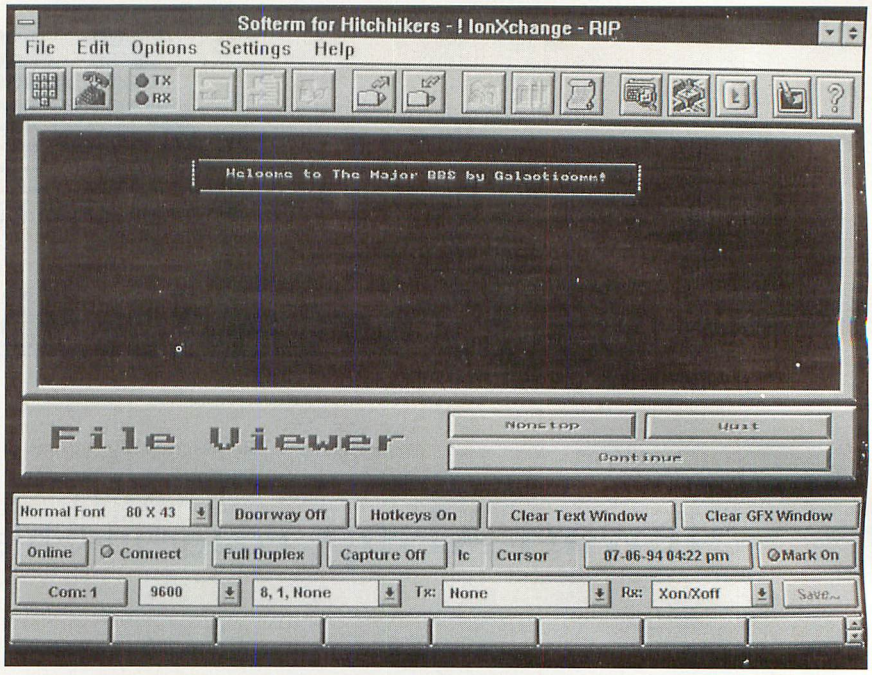
The MMA is a twelve-year-old not-for-profit educational and professional organization; its 1000 members include a wide variety of information processing professionals responsible for or highly influential in standards setting, strategic planning, and purchasing within their organizations. The MMA hosts regular meeting programs at seven chapters around the country (Dallas/Ft Worth, Denver, Portland (Oregon), DC Metro, Los Angeles, New England (Boston), and New York Metro).

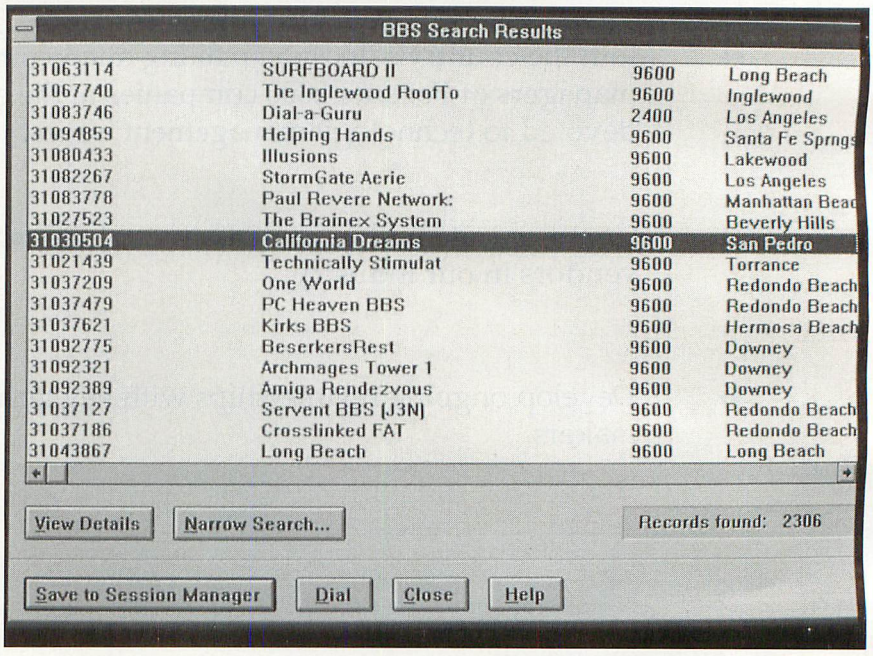
move in the opposite direction to the last window.

These shortcut keys are handy for navigation, whether the windows are maximized or minimized. If they're maximized, you need to consider the number of windows you have open. At some point, it takes longer to scroll than it does to close a window and select another icon. But working maximized windows is probably my favorite method for up to six or so windows.

Keystrokes are clearly useful for moving between File Manager directories. Ctrl-Tab and Shift-Ctrl-Tab shortcuts are particularly useful when moving back and forth between two directories. However, herein lies another potential DOS mind-set pitfall. If you have eight windows open but are currently doing a lot of work with just two of them, consider temporarily iconizing the other six. Tiling just the two you're using is likely to make you more efficient. You still have to consider the trade-off you get by working in a smaller area. But it's rare that you can't work efficiently in the area that a two-way split gives you in each window.

If you're still just a little short, drag the frame of the lower-window down to size it over your icons and the frame of the upper-window down to size it over the second window's title bar. This gives you the largest useful area in each of the two windows. If one directory has more files than the other, you may wish to first resize the windows to give proportionately more area to the larger directory.





Keyboard Essentials

It should be evident by now that keystrokes are still essential in a graphical environment for both navigation and access to dialog boxes and shortcuts to menu functions. Well-written graphical applications should let you perform any function without a pointing device simply because it's sometimes more efficient to hit a key than to take your hands off the keyboard. Few things are more annoying than the lack of these abilities in a graphical application.

Fortunately, *Windows* developers generally seem to do a better-than-average job in this area. Keyboard access isn't an intrinsic superiority of *Windows*. Mac applications have keyboard access in dialogs and shortcut keys as well. It's just that, in my experience, *Windows* applications tend to have more ecumenical keystroke access than those on the Mac.

Perhaps, *Windows* has inherited a bias to the keyboard from its DOS heritage. Or it may be true, as I've heard rumored, that power-user Bill Gates himself favors the keyboard for its speed. Whatever the reason, I never seem to run across inaccessible functions in applications from experienced *Windows* developers like Microsoft and Lotus.

I find it very annoying whenever I discover a button or box that's accessible only with a pointer. To me, mouse-only access is an undesirable Mac trait. It's possible that, early on, Apple tried to enforce the graphical paradigm among developers to the exclusion of the keyboard. It may alternatively have resulted from a genuine, though misguided, attempt to make things better through social engineering.

As sometimes occurs, there are people who will ignore social engineering in favor of what works best for them. And there are people who insist on a keyboard over a mouse. Forcing pointer use for something that could be done faster via a keyboard seems to me as wrong as forcing handwriting on users just because they have access to a stylus. For a proficient typist, handwriting is a lot less effi-

cient than keyboard input. (Could this be one reason why the Newton hasn't met with great success?) In much the same way, consistent keystroke alternatives to the mouse can be much faster than the tedium of accurately positioning the pointer over small boxes and buttons.

Superior keyboard support is a *Windows* advantage that's well worth preserving. When you find an application has accidentally omitted keyboard access to some button or box, be sure to report it as a bug. Keystroke access is important to being or becoming a power user. It's the highway you'll want to use as you learn your applications and/or develop your typing skills. If you want them to be there when you need them, make sure every button and box in every dialog can be accessed by a keystroke. Don't let developers dilute this capability until voice recognition has completely replaced the keyboard.

Windows on Wayne's World

That's "world" as in World Wide Web. Now that there's a graphical face on the Internet, *Windows* is poised to become the entry way to the global community. Of course, a lot of other platforms are supported by the developers of Internet software. Most of the developers undoubtedly have Unix workstations on their own desks. But the vast number of *Windows* users makes it by far the most-attractive market for which to write applications. This is good news and bad news.

It's very good news to the wide world at large. A major reason that the Internet's 25- or 30-million users almost all seem to be 19-year-olds is that it's immersed in the arcana of Unix. *Windows* will bring the information highway that much closer to the average unsophisticated user who isn't forced to use it by a professor. In the end, the information superhighway will do much more than the multimedia CD-ROM to enrich the lives of ordinary people—those who view a computer as little more than an information appliance. The Internet isn't only the first step on the information superhighway, it's an infrastructure that's been around for decades.

The bad news comes to the Unix users who have pretty much had exclusive dominion over the net. They'll hate all the "newbies" poking about in confusion, lacking net manners and unwilling—or too lazy—to read the FAQ (frequently asked question) files that are supposed to straighten them out. But the newbies will adjust. So will the techno-elite old guard. In fact, once they find out how easy it is to use windowed net applications, perhaps through the same applications running on *X-Windows*, more than a few Unix types will convert from the command line.

Meanwhile, the rest of us will be accessing the net from every nook and cranny of the planet through cheap clones and notebook computers running my favorite environment. Initially, a lot of what you'll find will continue to be straight text. Most of the current action is in UseNet News groups, Gopherspace and FTP sites. But the WWW is where the future is. It has sound and pictures—and movies (if you have the transfer rate to support it). It also has hypertext, which makes finding things even easier than clicking on a Gopher menu item.

Hypertext's keyword and image links are embedded right in the context of a page. A mouse click brings up sound, graphics or other binary data or shoots you off to another page. That your new page might be on the other side of the planet is of no more consequence than it is when you use Unix commands. However, there's a huge difference. Clicking on a link requires no knowledge of the address. Just click, and off you scoot!

Virtual shopping malls are just some of the first sites to appear on the Web. There are many repositories of information, including some popular magazines. There are also real-world places with pages on the Web. You can already look in and see the decor of a nightclub in Mountain View, CA or visit the nearby Stanford mall. Can you imagine travel when almost any point of interest is available this way? Every vacation will begin with a look at the places you're going to visit. To arrange your lodgings, you'll simply click on an inn that suits you.

The weather, already available on the net, will look more like the weather on your local evening news program. Its commercial potential will eventually attract anything you can imagine to the Web.

A number of real-world malls are on the Web. Stanford's pages even include maps that lead to the local establishments. But the most-ambitious project is an entire city connected to the Web: The Blacksburg Electronic Village in Blacksburg, VA. "Welcome to the Blacksburg Electronic Village." begins one page, "Here in the rolling hills of Southwest Virginia between the Blue Ridge to the east and the Appalachians to the west is a community of people working together with diverse partners to develop a new idea—linking an entire town electronically, both to local resources and to the global resources comprising the much heralded 'information superhighway.' You can't see it in the chilly morning fog or among the multi-colored autumn leaves...but the changes are already starting to take place." Changes indeed. Who would have expected such a poetic interface to appear on his computer.

This page goes on to explain that the entire community is connected to the Web as proof of a concept. Residents of Blacksburg can use their Internet access to look up the time for the latest movie, arrange to meet a friend at the theater, find the bus line that goes there and then look up its schedule and the stop. If a resident is cleaning out the garage on Sunday, there's no need to wait for a city office to open on Monday just to find out the address of the nearest recycling center. A hyperlink to the information lets him take his newspapers to the center on the weekend.

All of these things are done via a series of mouse clicks or keystrokes. Hidden in the underlying source text of the Blacksburg pages are addresses like the one that gets residents the specials at the local supermarket: a href=http:// 128.173.241.-138/~wades/. (The Blacksburg page playfully points out how useful this particular link can be if you've just recycled the flyer.) When you click on the associated hypertext link that's visible on the Blacksburg page, this address is transparently executed by *Mosaic*. Then next thing you know, you're reading the specials. There are also navigation buttons that let you move back and then forward again along the path you've already traveled.

Although, we're still a few years from universal access to vast graphical repositories of information, it's on its way. The pipeline that's going to make transferring all the large binary files feasible is being built by telephone and cable-TV companies, companies are designing competing servers to deliver the programming, and the owners of content are making deals.

This is going to take a lot of new software. Some of this software is now available and some is in beta test. You may not usually think of using beta software unless you're a site for some developer, but many net applications are different in one important dimension. Quite a few of them are shareware, freeware or public-domain. Being freeware or shareware—and being so new—these products are sometimes distributed in release numbers lower than 1.0. This is something you don't see every day with commercial software. On the Internet, though, this is even more common than usual for shareware. You can actually download software directly from the site where it's under development. Talk about getting it fresh! Nevertheless, like all better shareware, the better Internet in these three categories is very near or at commercial quality.

A protocol stack is the most basic piece of the software you need to access the

Internet. The one you need for *Windows* is called a Windows Sockets (WinSock) protocol stack. It let's *Windows* talk to the net's TCP/IP interface. Commercial products like *Chameleon* and *NetCruiser* include their own WinSocks. There's also one notable shareware WinSock stack: Trumpet. It's available at a variety of locations you can access via the net. As with other shareware and freeware, you can download it for the cost of your connection.

Among the commercial applications available for the net are Netcom's *NetCruiser*, *NetManage Internet Chameleon*, *Mosaic*, *Qualcomm Eudora* 2.0, and *MKS Internet Anywhere*. Public-domain, freeware and shareware products include *Mosaic*, *Cello*, *Trumpet*, *WinVN*, *Qualcomm Eudora* 1.4, *WSIRC*, *Lview*, *Lview Pro* and *Wincode*.

Web browsers—*Mosaic*, *Cello*, *NetCruiser* and others—are the means by which you access the WWW. *Mosaic* is probably the most widespread stand-alone browser. Commercial versions of *Mosaic* are licensed from its developer, the National Center for Supercomputing Applications (NCSA). They're available in value-added version from such licensees as Spyglass and SPRY. Spyglass licenses its *Mosaic* to OEM customers. SPRY's *Mosaic* is licensed for distribution to end users. One of the first available products to include SPRY's *Mosaic* is the Internet in a Box package from O'Reilly and Associates.

NetCruiser is a proprietary application that requires you to use Netcom as your service provider. It has both a protocol stack and a Web browser. *Internet Chameleon* is also currently shipping. It doesn't have a Web interface, but it does have a protocol stack that supports one like *Mosaic*.

Over the next couple of columns, I'll cover some of the basic things you need to start your trip on the information highway. This will include resources where you can increase the depth of your net knowledge, service providers and software.

Not all of the software I'll cover actually provide access to the WWW. Many programs are limited to e-mail or e-mail in combination with other utilities—frequently, readers for UseNet News. These products are an essential part of the software package you'll need to take full advantage of the Internet. Many support functions, such as e-mail and graphics viewers, aren't always included with products that provide access to the Web. For example, a pair of *Windows* products that aren't Internet-specific but are closely identified with the net are the *LView* 3.1 (freeware) and *LView Pro* (shareware) graphics viewers. Both viewers are available on-line. They're also licensed to many universities for viewing and manipulating graphics files, particularly the .GIF and .JPG files most commonly downloaded from the Internet.

Resources

On the surface, being able to download the software you need to access the Internet from the net itself seems very attractive. In practice, there are a few problems. If you plan to use the Internet as a source of your *Windows* software, you need both an address and another method of accessing the net to do it.

If you already have an account, you can get most or all of the *Windows* software you need via a PC or other platform. However, before you can start, you need software for the platform you'll be using and the addresses of locations where the *Windows* software is available to the public.

One inexpensive and easily accessible source of the information you need is an Internet book, which is also a good way to learn about the architecture of the net and basic methods of accessing and retrieving information. They're available from most computer-book publishers.

Osborne offers a compendium of available resources in *The Internet Yellow Pages* by Hahn and Stout. It also offers *The Internet Complete Reference* by the same authors. This large book lists more than 750 Internet resources and includes extensive instructions for using Unix-shell-style commands to access the net. There's also a coupon for an introductory discount with an Internet-access service provider.

O'Reilly & Associates, perhaps the best known publisher of books on Unix, has a number of related titles, including *The Whole Internet: User's Guide & Catalog* by Krol. Like *Internet Complete*, this book offers both resources and instructions for navigating through the command-line interface.

Probably the most-useful book of this type for the PC user is *Hands-On Internet: A Beginning Guide for PC Users* by Sachs and Stair. This modest volume is available from Prentice Hall in a $60 edition that includes two diskettes, one of which is a copy of deltaComm Development's *Telix Lite Software*, a Unix-style shell for the PC, and the other is an interactive tutorial that teaches you how to use this command-line interface. It's a complete system for accessing the net. It's ideal for downloading *Windows* software via a university or other account you might have at your disposal.

A product like *Telix Lite* could also be used to provide you with command-line access on a regular basis. Inasmuch as this type of account is usually the least-expensive, there are applications, such as downloading large files, you may want to continue to do on such an account, even while you use *Windows* applications to browse and manage your mail.

On today's net, it doesn't hurt to have an appreciation for the way things are done from a Unix shell. This is the language all the old timers "speak," and they're the most widely available source of help and information. There are also analogs of these Unix commands in the repertoire of *Windows* software. Wincode, for example, is a very useful utility for encoding and decoding between binary and ASCII files coded in Unix-style uu-code. It or something like it is essential for exchanging binary files through UseNet news groups.

If you're going to access the Web and don't already have access to the Internet, forget about the command line and start with *Windows*. There are combination book/diskette products that bundle not only *Windows* software, but also offer discounts with service providers. The Internet Membership Kit from Ventana is available in flavors for several platforms, including *Windows*. It contains a very good subset of *Internet Chameleon*, called the *Chameleon Sampler*; downloading instructions and documentation for *Mosaic*; and two books. The *Windows* version of Ventana's own *Windows Internet Tour Guide* by Fraase is included, along with a copy of *The Internet Yellow Pages*. The access offer provides a full month membership and six hours of connect time with CERFnet.

Moon Valley Software produces what must certainly be the largest single resource product for the Internet and other current information-superhighway services. The company's $99 *Hitchhiking on the Information Highway* CD-ROM contains NetCom's *NetCruiser* and includes start-up kits for CompuServe, Prodigy, America Online and GEnie. You get free introductory accounts with all of them, too. However, what really makes this product worthwhile are its references. There's enough basic information to get even the rawest novice up and running. A multimedia video tour provides communications basics from modem installation to previews of the on-line services. Fully indexed texts for *Internet Basics*, *Zen and the Art of the Internet*, *Hitchhiker's Guide To The Internet* and the *Electronic Frontier Foundation Guide* to the Internet are provided. All can be searched for any word.

A number of other references, including a glossary of terms and Internet FAQs, are indexed as well. Mecklermedia Pocket Guides for both UseNet and e-

mail are furnished. Finally, the product includes its own *Windows* communications application, complete with terminal emulations, graphic-file viewer, popular modem file-transfer protocols and support for both TCP/IP and the Internet FTP.

Hayden offers The Internet Starter Kit by Engst, Low and Simon. It includes the *Chameleon Sampler* and several discount offers with a variety of service providers. This is a tome that isn't particularly well-written but is chock full of valuable information on the Internet and a wide variety of *Windows* software.

You can also sometimes acquire these resources as part of an introductory offer from your access provider. Earthlink is a local access provider in Los Angeles. Access providers have a server connected to the Internet with which they provide their customers an Internet address for a start-up charge and monthly fee. They also usually have a separate charge for connect time.

Earthlink includes the $30 Internet Starter Kit in its $50 start-up charge. The company also provides it's users with access to a local database of software, giving one-stop shopping for many of the freeware and shareware programs you'll want to download. Even at the low Earthlink rate of $2 per hour, this lets you save a few bucks in searches.

Once you have an account, you can get whatever remaining software you need from the net itself. If you get an account that provides the Internet Start-Up Kit, this may not be much. In addition to the *Chameleon Sampler*, the kit contains the shareware version of *Eudora* and the public-domain news-reader *WinVN*. However, you can also update these applications via the Internet. WinVN, for instance, is one of those applications you can get in any of several recent versions by FTP (file transfer protocol). It's available from titan.ksc.nasa.gov in a directory called /pub/win3/winvn.

In my next column, I'll provide brief reviews of *Eudora*, *WinVN*, *Mosaic* and some of the other software you'll need to navigate on the Internet. ■

Companies Mentioned

Earthlink
3171 Los Feliz Blvd., Ste. 203
Los Angeles, CA 90039
Tel.: 1-213-644-9500
CIRCLE NO. 164 ON FREE INFORMATION CARD

Moon Valley Software, Inc.
141 Suburban Rd., Ste. A1
San Luis Obispo, CA 93401
Tel.: 805-781-3890
CIRCLE NO. 165 ON FREE INFORMATION CARD

Microcomputer Q & A

By TJ Byers

In this column, I answer questions about all aspects of computer disciplines, both hardware and software, plus related electronic queries. You can reach me on America Online at TJBYERS, on CompuServe or Internet at TJBYERS@aol.com or by mail in care of *MicroComputer Journal*, 76 North Broadway, Hicksville, NY 11801.

Mac/PC MOdem & CD-ROM Marriage

Q. *I have a 486SX-25 PC and my wife has a Mac LCII. I want to replace my present modem with an external 14.4 fax/modem, and I'd like to use it for both computers. Is there a difference in modems for the two machines? Same question for an external CD-ROM drive.*—Dean Beck, Chatsworth, CA

A: Thankfully, most modems are based on a *de facto* standard set forth by Hayes many years ago. So the modem you buy for your 486 system will work with your wife's Macintosh. The modem simply plugs into the RS-232 serial port of either computer. As for the CD-ROM drive, buy a SCSI drive because it's fast and plugs into the Mac's built-in SCSI port or your PC's multimedia port. The drawback is that if your PC doesn't have a SCSI port, you'll have to buy a SCSI adapter card. I recommend one from Adaptec or Future Domain. Depending on the SCSI connector, you may also need to use a different cable for the CD-ROM drive when moving it from one system to the other.

Signing PC Faxes

Q. *I understand that if I have my signature faxed to me using a regular fax I can then add it to my* Windows *documents. How? I have tried inserting a*

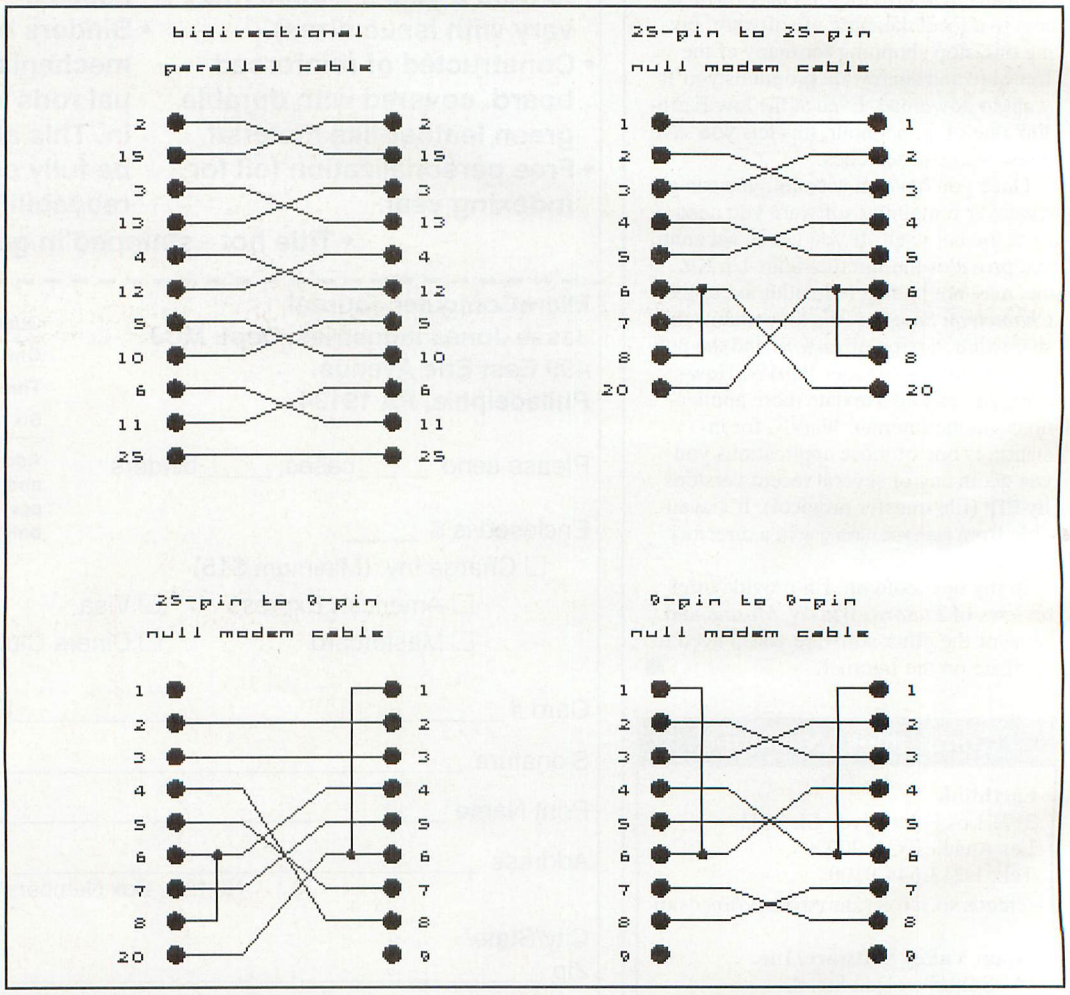


Fig. 1. Transferring data between PCs is easily accomplished using DOS's InterLink program and any of the cables shown above. The bidirectional parallel interface moves data much faster than the null modem's, but it's pretty much limited to 10 feet in length because of external noise problems.

faxed document into WinWord *without any luck.*—Louis Lamar, Newhall, CA

A. Fax a note to yourself and use your fax software to convert the incoming fax to a .BMP or .PCX file and pop it into *Windows* Paintbrush. Using the Scissors option, highlight the signature only, then use the Copy To command under Edit to save the signature in a new .BMP or .PCX file. You can now put the signature into a *Windows* document as a graphic, as follows:

Open the signature file in Paintbrush, highlight the signature using Scissors and attach it to the Clipboard via the Copy command. Now go into your target document, move the cursor to the desired signature location and Paste it in place. Since the Clip- board still holds the signature graphic, you can proceed to another document and do another paste—which saves time when you have many documents to sign. By the way, you can do the same thing with logos.

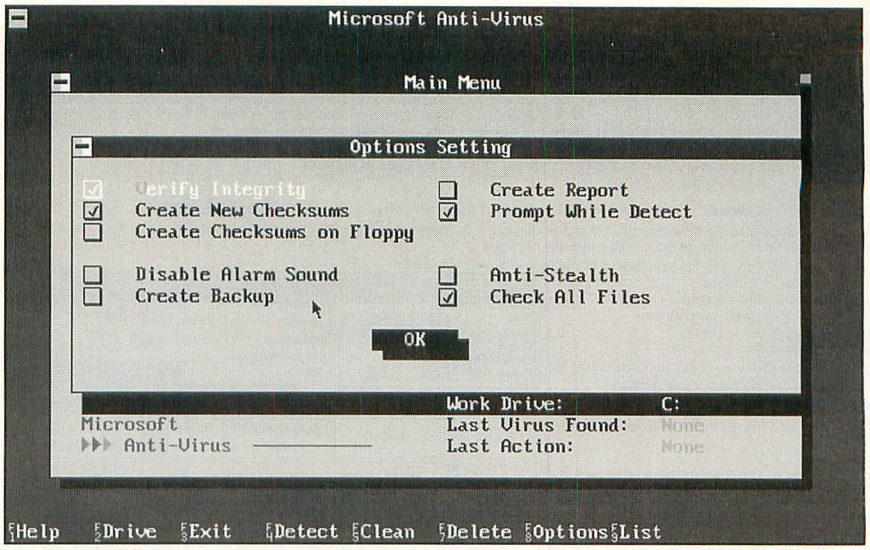


Fig. 2. VSAFE and VSAV, both of which come free with DOS 6.2, are virus-scanning programs that can protect data from a virus infection. Use VSAFE when working in DOS and VSAV (above) when working in *Windows*.

Transferring Data Between PCs

Q. *Do you know the pin assignments for the bidirectional parallel cable needed to run DOS 6.0's InterLink program? Someone told me the information was in the MS-DOS 6.0 book, but it's not in mine. I heard that this pinout is the same as that used by the Brooklyn Bridge and LapLink cables.*—Jim Jones, Birmingham, AL

A. You heard right. The standard bidirectional parallel cable is used by many software programs—including InterLink—for the transfer of data between PCs. The pin assignments are shown in Fig. 1. You can also use any null modem (also shown in Fig. 1), including those sold by Radio Shack, to InterLink two PCs. The advantage is that the null modem's serial cable can be several times longer than the bidirectional parallel cable (which is pretty much limited to 10 feet). The downside is that it takes about five times longer to move the same amount of data, which can be an hour or more for large or multiple file transfers.

Windows Won't Load

Q. *When I turn on my PC and try to start* Windows, *my 486 computer flashes the opening logo but immediately returns to the DOS prompt. But if I try a second time, it works. Why can't I open* Windows *the first time, but always the second?*—Antonio Castillo, Chula Vista, CA

A. I've seen (and actually experienced) this problem more than once. Unfortunately, there's no simple answer. First I'd suspect a TSR driver that's not loading properly on the first try. For instance, it could be a third-party disk cache that you may be using in place of DOS's SmartDrive. Next I'd suspect a hardware conflict of some kind that's a result of adding a sound card, internal modem or software application that's claimed an already spoken-for I/O port or interrupt (IRQ).

To pinpoint this problem, use a good diagnostic utility such as *AmiDiag* (1-800-685-6244) or *Micro 2000* (818-547-0125). Beyond this, all I can suggest is that you may have a "General Protection Fault" error that corrects itself after the first try. The cure, if this is the case, is to reinstall *Windows*. If you decide to go this route, save your *Windows* .INI files in a safe place so that you can restore your original setup if need be.

Not Enough Memory for Games

Q. *I'm having a problem with my computer that's really puzzling. I have two popular games that I like a lot, but when I try to run them I get a "Not enough memory" message. I have 4M of RAM and more than 100M of free disk space. Do I need more memory?*—Carlton Taylor, Scarborough, Ontario, Canada

A. You don't really need more memory, you just need to change the way you use the memory you have. The problem is you're trying to run your DOS games from *Windows*. This is fine—if you have 8M of RAM. You don't. For the games to work, simply quit *Windows* and run the game from the DOS prompt. However, 4M is close to the minimum amount of RAM required by *Windows*. So if you upgrade to 8M you'll not only be able to play your games, you'll also see a speed improvement in many of your *Windows* applications.

Microsoft *Access* Memory Woes

Q. *I'm having trouble loading* Calendar Creator Plus *when running MS* Access. *I get the error message "Not enough memory—close other windows applications and try again." I've ensured that all other apps are closed before attempting the process. I have a 486SX-25 with 8M of RAM —plenty enough, I'd think. More perplexing is that all other MS* Office *applications work fine with* Access. *I'm getting very frustrated. Any suggestions will be greatly appreciated.*—M. Galipeau, Lewiston, ME

A. According to Microsoft, *Access* requires 6M of RAM. It appears that loading *Calendar Creator Plus* on top of it is more than *Windows* is willing to handle. The reason *Access* runs with other Microsoft *Office* applications is because they share common code that *Access* has already loaded into RAM. You can try running *Calendar Creator Plus* first and see if that works. If not, you'll have to add more memory to your system—which becomes expensive when you pass the 8M mark if you have to remove your present 1M SIMMs and replace them with 4M SIMMs, which go for about $150 each.

More Memory Problems

Q. *I often have to convert graphics formats from one format to another in my work and find that* HiJaak *is my favorite conversion program. Unfortunately, I*

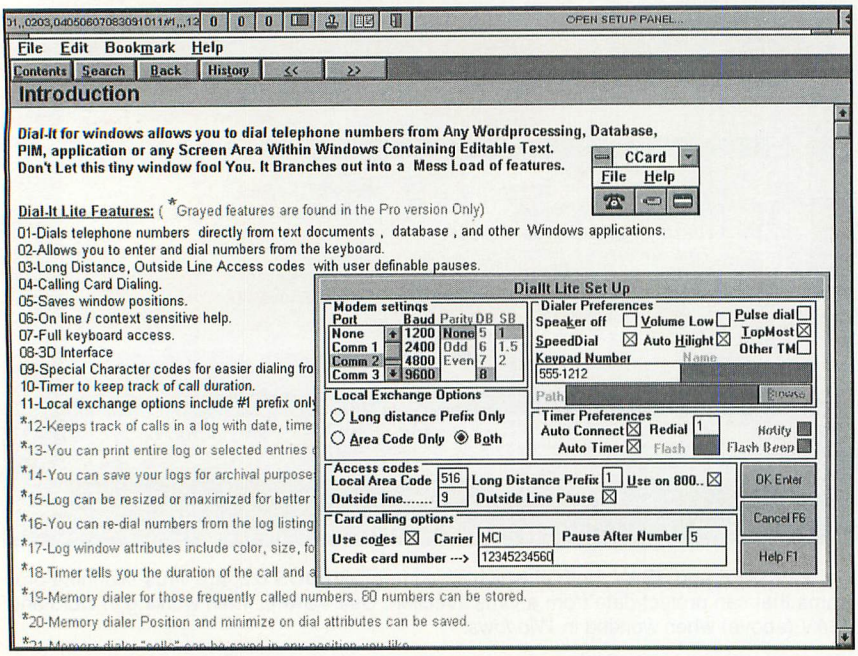


Fig. 3. *Dial-It* is a simple *Windows* shareware program that lets you dial phone numbers from virtually any *Windows* application by simply clicking on the number.

keep getting "Not enough memory" errors after I use HiJaak, *which forces me to quit and restart* Windows *to clear the problem. Although I can tolerate the inconvenience, I'd rather not have to. What can I do?*—Carl Phillips, Los Angeles, CA

A. You didn't say which version of *HiJaak* you're using, but I've noticed that some versions—and a few other programs, like *PhotoFinish*—eat memory and then refuse to free it up when they're done. Use a utility like *WinProbe* (800-683-6696) to free up your memory after using one of these programs. If this doesn't work, check your .INI files for strange or conflicting entries. I once had a corrupt application .INI file (*not* the SYSTEM.INI file) that triggered the "Not enough memory" message. Deleting the application along with its .INI file and reloading the application solved the problem.

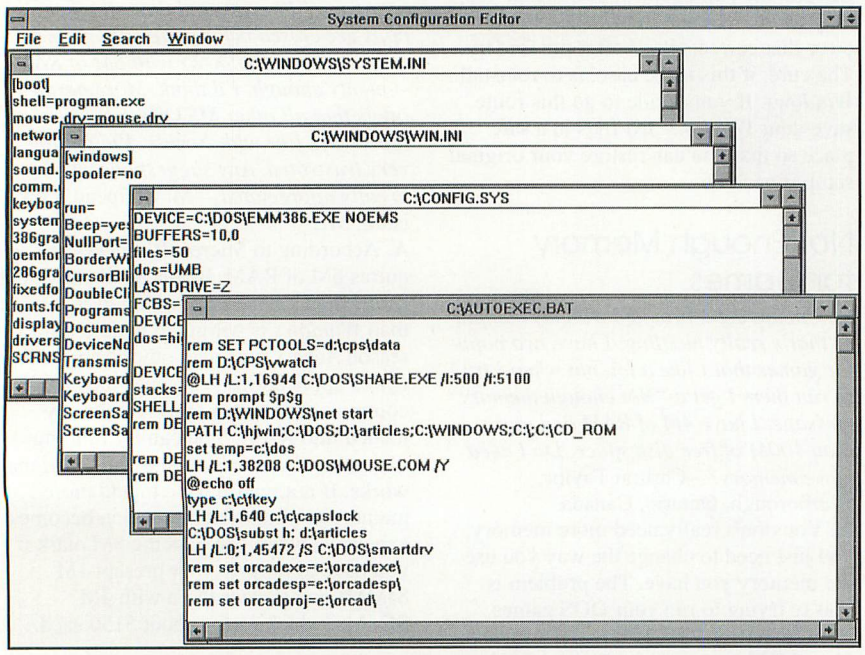


Fig. 4. Reader Tip: A quick way to make changes to your system files—AUTOEXEC.BAT, CONFIG.SYS, WIN.INI or SYSTEM.INI—is to run the SYSEDIT.EXE utility located in the *Windows* directory. Simply open the File menu and select Run. This program will let you change all four files without you having to open them individually, and it saves your old files with an .SYD extension, in case you mess up and need them back.—A. Rosen, New York, NY

Personal Network Security

Q. *I work in an office where four to seven persons share the use of two PCs. However, my current project requires exclusive use of one PC—which I will add to the system, making for a total of three. The problem is that the two existing PCs in my department are what I consider "unsafe" in regards to viruses and other tampering caused (unintentionally, I hope) by others. How can I plug my new PC into the network while keeping my data secure? Is there any software or hardware available that can prevent others from using my PC? Would changing to OS/2 alleviate the danger?*—Sean McKeown, via Internet

A. There are several things you can do to protect your computer and its data. Viruses are easily prevented by installing a virus scanning program such as VSAFE or MSAV (Fig. 2), which come free with DOS 6.2, or a third-party application like *The Norton AntiVirus*. Norton also makes a program called *Disklock* that prevents invasion of your system using password protection, file locking and file encryption. *PC Tools*, from Central Point Software, also contains similar utilities. However, you may not have to spend money to protect your system. The key that came with your PC—you know, the small (usually round) one that fits in the front panel—prevents anyone from using the keyboard in your absence. A screen saver (*Windows* has one) can hide your files from prying eyes when you're away. And many PCs have password protection built into their CMOS setup. Also, it's quite likely your network has similar safeguards already built-in. Ask your system administrator (the person in charge who maintains the network) for details. Finally, OS/2 won't give you any protection DOS can't provide.

Enhanced IDE

Q. *What's all the fuss about enhanced IDE? Can I add it to my PC?*—Jay Lee, San Francisco, CA

A. Enhanced IDE does several things, all of which are designed to improve IDE performance and flexibility. For example, instead of relying on your PC's slow expansion slot, the enhanced IDE interface can plug into the local bus—the same fast

bus where the CPU lives—which may increase performance in some applications by as much as three times. The enhanced IDE standard also breaks the 528M hard disk barrier, supporting devices up to 1.2G, and it lets you install up to four devices without special hardware. However, enhanced IDE must be built into both the system and the drive for you to gain its benefits. which means you'll need an empty local bus slot and matching enhanced IDE controller card—plus a new hard disk. Also be aware that the technology goes by several names: Western Digital calls it Enhanced IDE, Seagate calls it Fast ATA, and Maxtor prefers High Performance ATA.

New Hard Disk is Faster

Q. *I just bought a second hard disk for my computer. My current hard disk is a slow (23-ms) 40M drive. When I add the new hard disk, which is a 17-ms drive, what speed will my system run at? A friend told me that the computer automatically defaults to the speed of the slower drive.*—Jim Gorman, San Jose, CA

A. The speed of the hard disk determines the amount of time it takes to read and write data to and from the disk—only. It doesn't affect the speed of the computer, but it will affect the speed of your applications. The 40M drive will always access data at 23 ms, and the new drive will always access data at 17 ms. My suggestion is to transfer all the files on your 40M hard disk to the new hard disk and make it the first drive. Then install your old hard disk as drive number two. This arrangement lets your system boot faster, and you'll notice a speed improvement in your applications.

If you have IDE drives, this upgrade is done by unplugging the old drive and plugging the new one into the same socket; the old drive plugs into the empty socket. And don't forget to change your CMOS setup.

Windows Phone Dialer

Q. *Can you recommend a small, simple* Windows *phone dialing program? I don't need something to keep phone numbers for me. I just want to be able to highlight the number, give a command and have the program dial the number—recognizing whether it needs to put a 1 before the number.*—Jeff Greenberg, via Internet

A. There's a really nifty shareware program called *Dial-It* (Fig. 3) that can be found on most on-line services and many popular BBSes. It comes in a lite version, DIALITE.ZIP, and a Pro version, DIALITPR.ZIP. The program not only inserts the 1 when needed, but it also does credit-card dialing. Moreover, you don't have to highlight the number—just click on any part of it and *Dial-It* does the rest.

Can't Format Floppy

Q. *I have a problem formatting my floppy disks. When I use DOS's FORMAT command, my computer says "saving UNFORMAT information." After much grinding, I get an error message that says "Not ready. Format terminated." And then my PC won't let me read from that drive until I put in another disk. I've even tried to use the /u switch for unconditional format, with no luck. How can I stop this from happening, short of using my* Norton Desktop for Windows *Format Diskette utility?*—Jason Fawcett, San Diego, CA

A. It sounds like you're not supplying FORMAT with enough information. For example, if you're trying to format an IBM 2.88M diskette, you need to say: FORMAT A: /F:2.88. A 720K diskette needs the /F:720 switch, while a 360K, 5¼" diskette needs the /4 switch. You might also try using the /q switch in place of /u. Other than this, I can't see what the problem is, because *Norton*'s format utility seems to work okay. ■

Internet Watch *(from page 72)*

From Prentice Hall...

The Internet Book: Everything You Need to Know About Computer Networking and How the Internet Works
by Douglas Comer. *(Soft cover. 336 pages. $24.95.)*
In non-technical terms, this book explains how computers communicate and what the Internet is and what it can do for you. It focuses on the services the Internet provides, using analogies and examples.

Organized into four sections, it begins with communication-system concepts and terminology and then moves on in the second section to a review of the history of the Internet and its incredible growth. The third section describes basic Internet technologies and capabilities and examines how Internet hardware is organized and how software provides communication. The last section describes services currently available on the Internet.

Internet Anywhere: All You Need to Test Drive Internet Mail and Usenet News For 30 Days
by James Gardner. *(Soft cover. 460 pages. Floppy disk. $39.95.)*
This book/software package offers *Windows* users easy access to the Internet's most popular tools—e-mail and Usenet newsgroups—for 30 days. It automatically configures and initiates an Internet account with a service provider, eliminating the hassle of having to find an Internet access provider and configuring your communications software to be compatible with the provider's UUCP service yourself.

With this package, you get easy-to-use *Windows*-based Internet mail and news software, auto-dial access to an Internet service provider or alternate and free use of *Internet Anywhere* software for 30 days. The book guides you as an Internet user through the software and Internet basics. It's organized into several sections that cover getting started with the software, Usenet news, electronic mail, other *Internet Anywhere* software and access providers. It also includes an international service-provider directory.

Internet Anywhere software includes network news capabilities, a mail reader and composer and a scheduler program. It lets you download newsgroup information and e-mail from the Internet, using the store and forward capabilities of UUCP. You can set up your computer to connect to the Internet at times when telephone discount rates are in effect.

The software provided in this package has some built-in limitations during the trial period and ceases to operate 30 days after it has been installed.

USENET: Netnews For Everyone by Jenny Fristrup. *(Soft cover. 320 pages. $24.95.)*
This book shows how to communicate with others in the Usenet newsgroups via posting articles, forwarding mail, sending follow-up articles to previous articles and simply reading the news using netnews programs.

USENET is organized into three parts. Part One introduces you to Usenet and its newsgroups, with a look at an existing newsgroup to let you explore the dynamics of discussions and learn basic terminology. Reference section Part Two contains the core list of Usenet newsgroups, lists the basic newsgroup and any subgroups, gives a description of each and lists the group's available FAQs. Part Three is a guide to getting access to Usenet.

(Continued on page 107)

Industry Watch By John Hastings

The AmCoEx Index of Used Computer Prices

In the computer industry, the company that controls the operating-system software can control the industry itself. IBM proved this axiom in the 1960s and 1970s when its mainframe operating-system revenues provided it with enormous profits. In the 1980s, IBM grossly underestimated the potential market for microcomputers and allowed Microsoft to retain the rights to PC-DOS and market it as MS-DOS. Some people now say IBM stands for "I Built Microsoft."

IBM is now making a concerted effort to wrestle some of its power and influence back from Microsoft with its latest attempts to market its *Windows* competitor, OS/2. Big Blue may even utilize late-night "infomercials" on television to promote its operating system. Many industry experts would like to see some degree of success for OS/2. This would ensure a balance of power and continued competition, with no one company controlling the industry.

1995 will bring remarkable changes in microcomputer operating-system software. IBM will announce the next version of its OS/2 operating system designed for smaller systems and individuals, Microsoft will release the next version of *Windows,* and Apple will finally license its operating system to other computer makers who will sell clones of the Macintosh computer.

IBM's OS/2 has been a success with corporate customers, but not with individuals. IBM hopes to remedy that with its new version. The new software will probably be called Personal OS/2. It's expected to run with only 4M of memory, include a suite of productivity applications and provide one-button access to all features of the Internet. IBM expects the new system to rival the next version of *Windows* and beat it to the market by eight months.

Microsoft has stated the next version of *Windows* will be called *Windows 95*, rather than *Windows* 4.0, as expected. Most software with ".0" in its has had serious problems. Many experienced users wait for the .1 version to adopt new software. Some think Microsoft adopted the new naming convention to circumvent this perception.

Apple unveiled a new logo for its operating system that will allow the company to give it a recognizable identity separate from the normal Apple logo. When other companies begin to sell Macintosh clones, they'll use the new operating-system logo as its identification without confusing the hardware as being that from Apple.

After being one of the first companies to introduce a subnotebook computer, Apple may also be one of the first to withdraw from the market. It's expected the next PowerBook Duos introduced this spring will be the last Duos Apple produces. Sales of sub-notebooks have been disappointing to most manufactures. Even Compaq and IBM's sub-4 lb. computers haven't come up to expectations. Most of these computers have smaller keyboards and no internal floppy drive. These limitations have been too much for many buyers.

Two models of PowerBook Duos will be announced in May, both of which will have color screens. With prices of color screens dropping and demand increasing, we may be approaching the end of monochrome screens on all notebook computers. In the past, most color screens were either expensive, high-quality active-matrix ones or the cheaper, poor-resolution passive-matrix ones. Today, dual-scan passive-matrix screens offer an excellent compromise with an affordable price and sharp, clear colors.

As Intel continues to cut prices of its Pentium CPU chips, Advanced Micro Devices has countered with faster 486 chips. AMD recently announced a new 486 that runs at 80 MHz and expects to ship large quantities of a 100-MHz version before the end of the year. The lower prices on these chips will certainly translate into lower prices of new and used computers this fall.

Compaq Computer announced a new line of computers that surprised the industry. This is the first model from the computer giant that will be built without use of any Intel CPU chips. All of the new systems will use chips from Advanced Micro Devices. Compaq appears to be feuding with Intel over the fact that Intel has assembled complete systems for many of Compaq's competitors. Intel may retaliate by withholding its Pentium chips from Compaq. However, NexGen, a company partially owned by Compaq, announced its Pentium-class chips this week. It expects large quantities to be available before the end of the year.

Demand for used laser printers, especially the Hewlett-Packard LaserJet series, has always exceeded supply. Unlike technological advancements in computers, newer laser printers haven't enticed users to sell their older printers to upgrade. The new Color LaserJet may change this situation somewhat. Selling for slightly less than $6,000, the new HP color printer may cause many businesses to sell their older monochrome printers to upgrade. In addition to printing four pages per minute in color, the new printer can print up to 12 pages per minute in monochrome.

Novell recently announced release of a revolutionary new software development system called *Visual AppBuilder*. Years ago, the development of computer applications was a cottage industry. Many large software companies grew from individuals or small groups that were developing new software applications. New graphical interfaces have made development of new applications more difficult. Most new applications today are developed by large orga-

Prices For Used Computers as of October 6, 1994

Machine	Average Buyer's Bid	Average Seller's Ask	Close	Change
IBM PS/2 Model 70, 60M	$400	$675	$500	–$50
IBM PS/1 486DX2/50, 253M	1,125	1,450	1,200	+50
IBM PS/2 Model 9, 160M	1,200	1,600	1,300	—
IBM ThinkPad 350C	1,900	2,400	2,200	—
IBM ThinkPad 700	1,000	1,700	1,225	–25
IBM ThinkPad 720	1,600	2,000	1,775	+50
AST 486SX/25, 170M	700	1,250	925	—
AST 486DX/66, 340M	1,350	1,900	1,600	–100
Dell 386/33, 100M	600	1,000	750	–50
Dell 486DX/33, 240M	850	1,500	1,200	+100
Gateway 386/25, 80M	400	800	575	–25
Gateway 486/33, 120M	800	1,200	1,000	–25
Clone Notebook 386SX, 40M	500	900	800	+100
Clone 386/33, 80M, VGA	450	900	675	+50
Clone 486/25, 120M, VGA	700	1,200	1,025	+50
Clone 486DX/33, 240M	800	1,425	1,125	–75
Compaq LTE 286, 40M	300	675	550	+50
Compaq Contura 320, 60M	500	1,000	875	+75
Compaq Contura 4/25, 120M	1,100	1,600	1,300	+25
Compaq Deskpro 386/20e, 100M	500	800	650	+25
Compaq Deskpro 486/33, 120M	1,100	1,650	1,225	–75
Mac Classic II, 80M	400	800	475	–50
Mac IIsi, 160M	600	900	700	–75
Macintosh IIcx, 80M	400	700	475	+25
Macintosh IIci, 80M	600	950	675	–100
Macintosh IIfx, 80M	700	1,250	800	–100
Mac Quadra 700, 230M	1,100	1,600	1,250	+25
Mac Quadra 800, 500M	2,350	2,900	2,350	–150
PowerBook 140, 40M	700	1,100	800	–50
PowerBook 170, 40M	800	1,350	925	–150
PowerBook 180, 80M	1,200	1,700	1,500	+50
LaserWriterPro 630	1,500	1,975	1,600	–25
Toshiba 1900, 120M	1,000	1,700	1,075	–75
Toshiba 3200 SXC, 120M	1,850	2,950	2,300	–175
Toshiba 3300SL, 120M	1,050	1,600	1,225	–75
Toshiba 5200, 100M	850	1,250	1,000	–100
HP LaserJet II	350	850	675	–100
HP LaserJet IIIP	350	950	500	—
HP LaserJet III	650	1,000	700	–125
HP LaserJet IV	900	1,300	975	–100

John Hastings is the president of the American Computer Exchange Corp., which has matched buyers and sellers of used microcomputer equipment since 1988. For more information contact the American Computer Exchange Corp. at 800-786-0717.

nizations that have experienced programming staffs.

Novell's new product will allow programmers, and non-programmers alike, to develop sophisticated new applications in one-tenth the normal time, without forcing them to learn a programming language. These new developers will start new businesses that could change the face of the industry. After development, the new applications can be compiled to run under both Macintosh and *Windows* operating systems.

Many companies aren't surprised to learn that their older computers may be worthless. However, most are surprised to find some older computers are sinking to negative values. Due to some toxic elements found in various computer components, most older systems can't be placed in dumps and landfills. They must be disposed of properly. Several companies now charge corporations to remove older XT and 286 desktop computers. Slower 386 computers may soon attain the dubious distinction of having a negative value. ■

• PIC16C5X Microcontroller Family. The PIC16C5X family consists of the PIC16C54, PIC16C55, PIC16C56 and PIC16C57 microcontrollers. All four of this family's members are low-cost, eight-bit, EPROM-based CMOS microcontrollers. Differences in the four PIC16C5X parts are in oscillator type, number of available I/O pins and size of the internal EPROM and RAM. The PIC16CXX family of devices have similar pinouts. Table 2 provides an overview of the PIC-16C5X devices. Figure 6 is a comprehensive block diagram for the entire PIC16CXX family.

Only 33 assembler instructions are associated with the PIC16C5X family. Most of them execute within a single processor cycle, the exception being program branch instructions that take two cycles to complete. Each PIC16C5X instruction word is 12 bits in length with the mnemonic (opcode) and operand (register, memory location or direct data to be manipulated) fully defined within the 12-bit word.

The PIC16C5X can operate with a 20-MHz clock, producing 200-ns instruction cycles. Most of the other popular microcontrollers operate at much lower clock speeds, with microsecond cycle times and use instructions that consume multiple bytes of program space per instruction.

High-speed PIC execution coupled with the code efficiency offered in the single-word instruction set boosts PIC performance a magnitude beyond many microcontrollers in its class. An additional plus is that usually a 2:1 code compression ratio is also achieved.

Data-memory (RAM) bus in the PIC16C5X is eight bits in length, while the program-memory (EPROM) bus is 12 bits in length. Using the Harvard dual-bus configuration permits the PIC16C5X family to perform high-speed bit, byte and register operations.

Summing up, the PIC16C5X family consists of what's known as the 12-bit core devices. Depending upon the device you select, EPROM program memory can range from 512 to 2K 12-bit words of program memory, 32 to 80 bytes of internal RAM, 12 to 20 bidirectional I/O lines, an oscillator startup timer, dc-to-20-MHz operation

```
    CALL        DELAY           ;GIVE LCD TIME TO EXECUTE

    BCF         CONTROL,E       ;LOWER E

    CALL        DELAY           ;COMPLETE COMMAND SEQUENCE

;********** TURN ON DISPLAY AND CURSOR
;
    BSF         CONTROL,E;RAISE E

    MOVLW       0CH             ;DISPLAY ON BYTE IS 0EH
    MOVWF       DATALINES       ;PRESENT COMMAND

    CALL        DELAY

    BCF         CONTROL,E       ;LOWER E

    CALL        DELAY

;********** SET ENTRY MODE TO MOVE CURSOR TO RIGHT
;
    BSF         CONTROL,E
    MOVLW       03H
    MOVWF       DATALINES

    CALL        DELAY

    BCF         CONTROL,E

    CALL        DELAY

;********** CLEAR DISPLAY AND HOME THE CURSOR
;
RESET
    BCF         CONTROL,RS      ;MAKE SURE RS IS RESET FOR SCROLL
    CALL        DELAY
    BSF         CONTROL,E
    MOVLW       01H             ;CLEAR DISPLAY COMMAND BYTE
    MOVWF       DATALINES       ;PRESENT COMMAND

    CALL        DELAY

    BCF         CONTROL,E       ;LOWER E

    CALL        DELAY

;********** DISPLAY THE MESSAGE
;
DISPLAY
    MOVLW       0
    MOVWF       OFFSET          ;INITIALIZE TABLE OFFSET VALUE

    BSF         CONTROL,RS      ;TURN ON WRITE DATA TO LCD BIT
    CALL        DELAY           ;
ROLLIT
    BSF         CONTROL,E       ;RAISE E
    MOVF        OFFSET,W        ;LOAD THE OFFSET VALUE
    CALL        TABLE           ;GO GET THE CHARACTER TO DISPLAY
    MOVWF       DATALINES       ;PUT CHARACTER OUT

    CALL        DELAY           ;EXECUTE

    BCF         CONTROL,E


    MOVLW       0FFH            ;SET SPEED OF SCROLL
    MOVWF       SPEED
SCROLL
    CALL        DELAY
```

```
        DECFSZ      SPEED,1
        GOTO        SCROLL

        INCF        OFFSET,1        ;INCREMENT OFFSET INTO TABLE

        MOVLW       10H             ;LENGTH OF MESSAGE IN TABLE
        XORWF       OFFSET,W        ;CHECK FOR END OF MESSAGE
        BTFSC       STATUS,2        ;CHECK FOR OFFSET=10H
        GOTO        RESET           ;YES = 10H
        GOTO        ROLLIT          ;NO..GO GET NEXT CHARACTER

;********** MESSAGE TABLE
;
TABLE
        ADDWF       PC,1            ;ADD OFFSET TO PC
                                    ;THIS RESULTS IN A COMPUTED GOTO
        RETLW       ' '             ;WHICH OFFSETS INTO THE MESSAGE
        RETLW       ' '             ;TABLE
        RETLW       ' '
        RETLW       ' '
        RETLW       'P'
        RETLW       'I'
        RETLW       'C'
        RETLW       '-'
        RETLW       'P'
        RETLW       'E'
        RETLW       'R'
        RETLW       'F'
        RETLW       ' '
        RETLW       ' '
        RETLW       ' '
        RETLW       ' '

;********** DELAY SUBROUTINE
;
DELAY
        MOVLW       0FFH            ;SIMPLE LOOP TO KILL TIME
        MOVWF       LOOPY
KILLTIME
        DECFSZ      LOOPY,1
        GOTO        KILLTIME
        RETLW       0

        ORG         PIC55
        GOTO BEGIN

END
```

Table 2. PIC16C5x CMOS Microcontroller Family Overview.

Product	Pin Count	I/O Lines	EPROM (E) or ROM (R)	RAM	Operating Voltage
PIC16C54	18	12	512 X 12(E)	25 X 8	2.5 to 6.25
PIC1654A	18	12	512 X 12(E)	25 X 8	2.5 to 6.25
PIC16C55	28	20	512 X 12(E)	24 X 8	2.5 to 6.25
PIC16C56	18	12	2,048 X 12(E)	25 X 8	2.5 to 6.25
PIC16C57	28	20	2,048 X 12(E)	72 X 8	2.5 to 6.25
PIC16C58A	18	12	2,048 X 12(R)	73 X 8	2.5 to 6.25
PIC16CR54	18	12	512 X 12(R)	25 X 8	—
PIC16CR57A	28	20	2,048 X 12(R)	72 X 8	—

Packages = PDIP, SOIC, CDIP Window, SSOP

HARDWARE SOURCES

If you prefer not to go it alone in fabricating a PIC-PERF breadboarding system, you can obtain a kit of parts from which you can build the configuration that suits your needs and budget. A number of options are available from:

E D Technical Publications
PO Box 541222
Merritt Island, FL 32954-1222

VISA and MasterCard are accepted. For telephone credit-card orders, call 407-454-9905. To contact the EDTP BBS, dial 407-454-3198.

Option 1: PIC-PERF pc board only, $30.
Option 2: PIC-PERF pc board; solderless terminal strip; all IC sockets; DB-25 female connector; 0.1-µF capacitors (5); all header pins, $52.
Option 3: Same as Option 2 plus DL-1414 intelligent display; 8- and 3-MHz ceramic oscillators; 10-MHz crystal; 27-pF capacitors (4), $82.
Option 4: Same as Option 3 plus LCD display; PIC16C54 EPROM version; and PIC16C55 EPROM version, $130.
PIC16C54/55/56/57 Programmer Kit: Includes all electronic components, pc board and software, $69.95
PIC16C64/71/74/84 Programmer Kit: Includes all electronic components, pc board and software, $49.95

Components for making your own PIC-PERF can also be obtained from:

Digi-Key
Tel.: 1-800-DIGIKEY

LCD display modules are available for $9.95 from:

BG Micro
PO Box 280298
Dallas, TX 75228
Tel.: 1-800-276-2206

Technical data for the Microchip PIC series of products and the *Microchip Data Book* can be obtained from:

Microchip Technology, Inc.
2355 W. Chandler Blvd.
Chandler, AZ 85224-6199
Tel.: 602-786-7200

and 2.0-to-6.5-volt operation, all contained within an 18- or 28-pin plastic or ceramic DIP package.

• **PIC16C71 Microcontroller.** The 1K x 14 EPROM-based eight-bit PIC-16C71 CMOS microcontroller is an improved 14-bit version of the processor core used in the low-cost, high-powered PIC16C5X family. The architecture of this microcontroller is de- designed along the lines of the PIC16C5X series, and its program code is basically the same, with some added mnemonics that are particular to the PIC16C71.

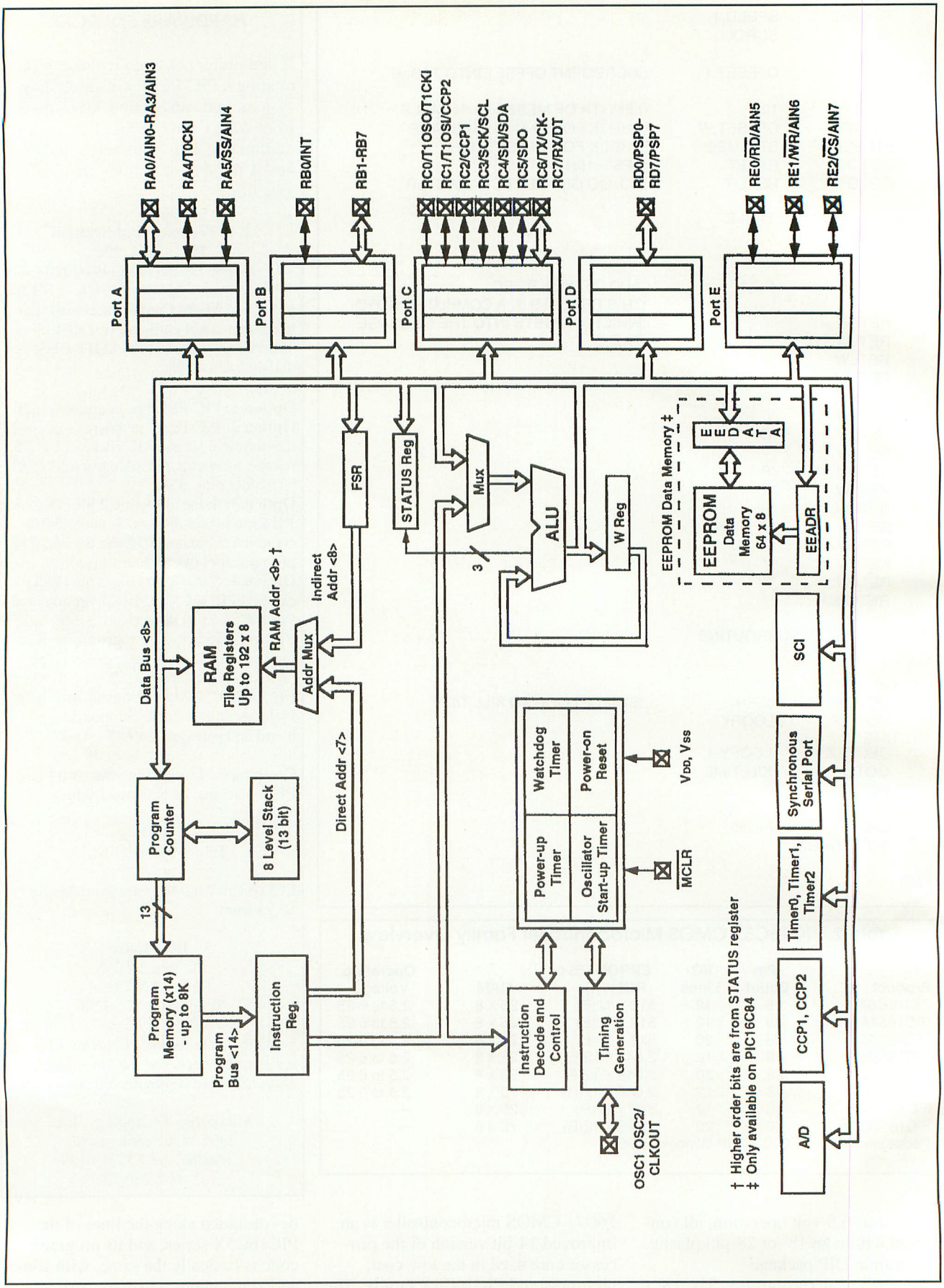


Fig. 6. PIC16Cxx architecture block diagram. **(Courtesy Microchip Technology Inc.)**

Listing 4. Code For Reading PIC16C84 EEPROM Data Memory

```
CLRW                    ;CLEAR W
MOVWF   EEADR           ;LOAD ADDRESS 0
BSF     STATUS,RP0      ;GO TO PAGE 1
BSF     EECON1,RD       ;DO A EEPROM READ FROM ADDRESS 0
BCF     STATUS,RP0      ;RETURN TO PAGE 0
MOVF    EEDATA,W        ;LOAD W WITH EEDATA CONTENTS
MOVLW   0x01            ;LOAD ADDRESS OF 0x01
MOVWF   EEADR           ;
BSF     STATUS,RP0      ;GO TO PAGE 1
BSF     EECON1,RD       ;DO A EEPROM READ FROM ADDRESS 1
BCF     STATUS,RP0      ;RETURN TO PAGE 0
MOVF    EEDATA,W        ;LOAD DATA JUST READ TO W
```

Listing 5. Working Example of Writing PIC16C84 Data Memory.

```
WRITEADDR0
    CLRW                ;CLEAR W
    MOVWF   EEADR       ;LOAD EEADR WITH ADDRESS 0x00
    BSF     STATUS,RP0  ;SELECT REGISTER BANK FOR EECONX
    BSF     EECON1,WREN ;ENABLE EEPROM WRITE ENABLE
    BCF     EECON1,EEIF ;MAKE SURE EEIF IS CLEAR

    MOVLW   0x55        ;THIS SEQUENCE MUST BE PERFORMED
    MOVWF   EECON2      ;IN THIS ORDER TO WRITE TO
    MOVLW   0x0AA       ;EEPROM DATA MEMORY
    MOVWF   EECON2      ;*
    BSF     EECON1,WR   ;*
WRITING0
    BTFSS   EECON1,EEIF ;CHECK FOR END OF WRITE
    GOTO    WRITING0
    BCF     EECON1,EEIF ;CLEAR EEIF BEFORE LEAVING
    BCF     EECON1,WREN ;DISABLE EEPROM WRITE ENABLE
    BCF     STATUS,RP0  ;SELECT REGISTER BANK 0
```

An on-chip analog-to-digital (A/D) converter is featured in the PIC16C71. Like its ancestors, the PIC16C5X series, the PIC16C71 contains an advanced RISC-like architecture. Its instruction set consists of 35 14-bit instructions that behave much like the PIC16C5X instructions. Most instructions execute within a single 250-ns processor cycle (with a 16-MHz clock), with program branches being the exception using, once again, only two processor cycles.

The very high performance attained by the PIC16C71 series can be attributed to instruction pipelining, a rich internal register set (48 addressable registers), and separate instruction and data memories.

Available in an 18-pin ceramic DIP EPROM package, the PIC16C71 has a transparent window through which erasure can be accomplished with an ultraviolet (UV) energy source for reuse. It's also available as an 18-pin OTP (one-time programmable) plastic DIP device that isn't erasable and can be programmed only once.

Data memory (RAM) bus in the PIC16C71 is eight bits wide, while the program memory (EPROM) bus is 14 bits wide. Use of the Harvard dual-bus configuration permits the PIC to perform high-speed bit, byte and register operations.

• **EEPROM-Based PIC16C84.** Very similar in operation and layout to the PIC16C71, the PIC16C84 is a fully-static eight-bit microcontroller with 1K X 14 EEPROM program memory and 64 bytes of user EEPROM data memory. Like the PIC16C71, all instructions are single words that are 14 bits wide. Each instruction cycle with a 10-MHz clock is 400 ns in length. The PIC16C84 also executes most instructions in a single cycle. You can expect typically 1-million erase/pro-

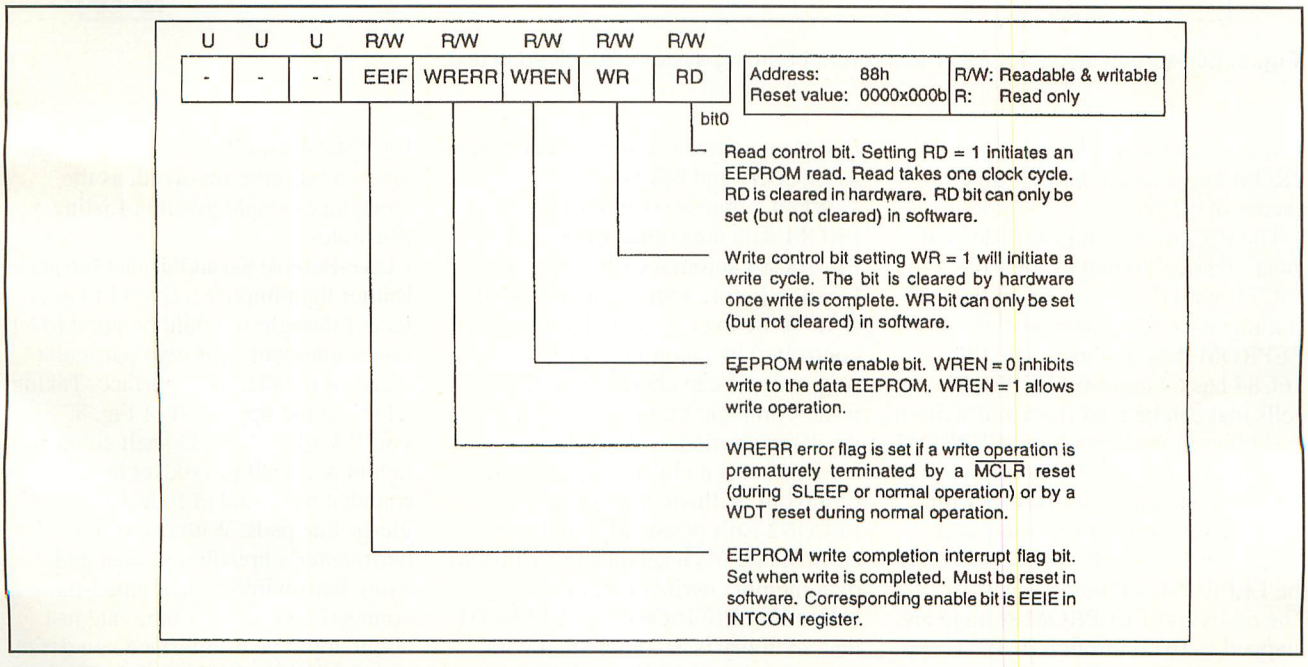


Fig. 7. EECON2 bit layout for PIC16C84 microcontroller. (Courtesy Microchip Technology Inc.)

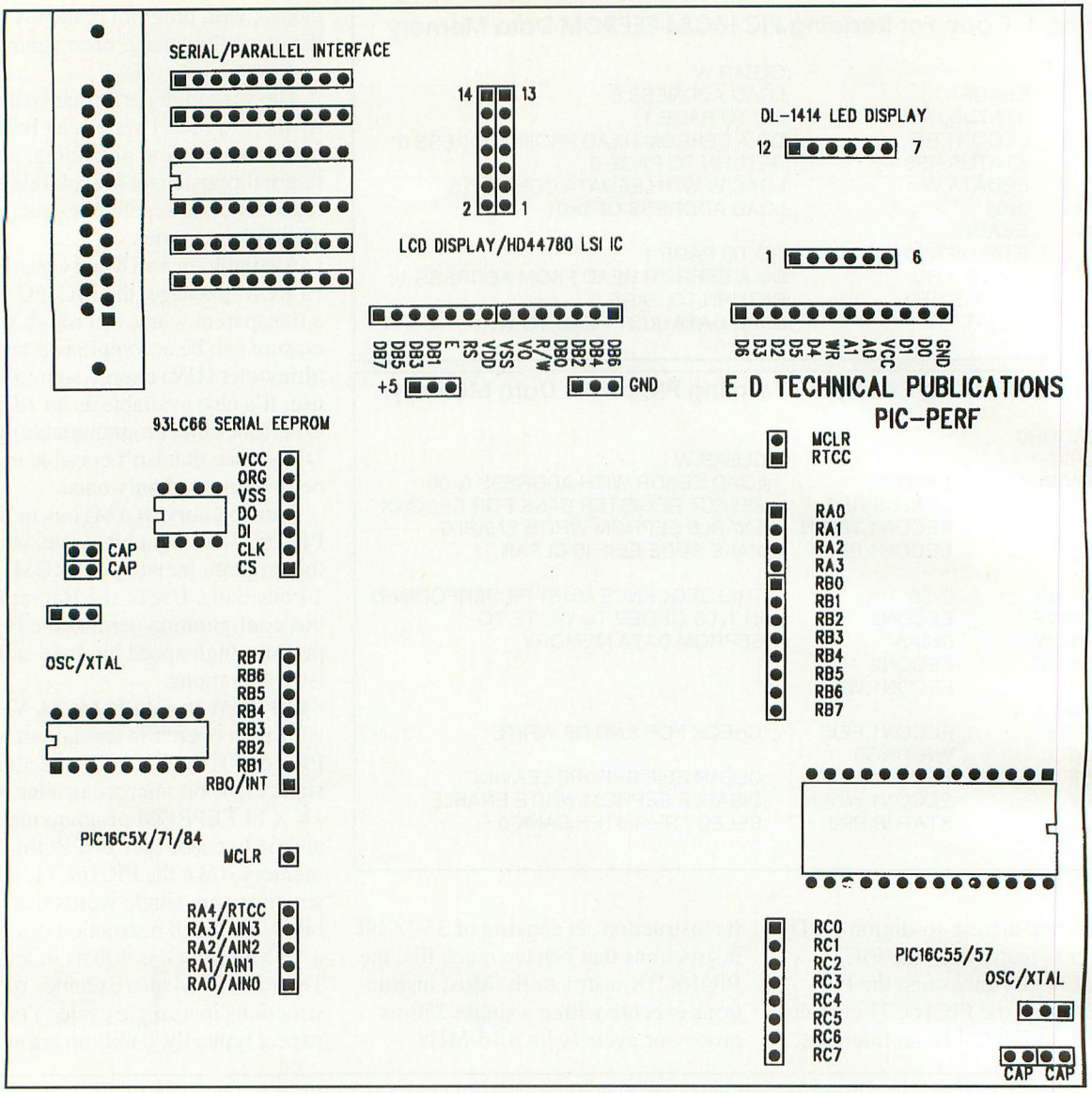


Fig. 8. Silk-screen layout for PIC-PERF breadboarding system described in text.

gram cycles for the device's user EEPROM and a data retention time in excess of 40 years.

The PIC16C84's register file is almost identical to that of the PIC16C71, with the exception of the special registers that enable use of the EEPROM data memory. The PIC16C84 has 64 eight-bit EEPROM cells that can be read from and written to during normal operation. EEPROM storage is accessed via two registers: EEDATA, which holds the eight-bit data for read/write operations, and EEADR, which holds the address of the EEPROM cell being accessed. The 64 bytes of EEPROM storage are mapped as 0x00 through 0x3F. To facilitate use of the EEPROM, there are also two control registers, identified as EECON1 and EECON2.

When a byte is written to the EEPROM data area, microcode in the PIC16C84 automatically erases the location before writing the new data to it. Write cycle time is 10-ms and is controlled by an on-chip timer. The programmer can choose to poll a write-complete bit or simply wait out the 10-ms period.

EECON1 is a physical register. Its bit layout is illustrated in Fig. 7. EECON2 isn't physically implemented. Instead, it's used during EEPROM data memory-write operations.

Reading PIC16C84 user EEPROM data memory is accomplished with the code given in Listing 4. Writing PIC16C84 user EEPROM data memory is a bit more involved, as the working example given in Listing 5 illustrates.

• **User-Defined Serial/Parallel Interface.** Rather than impose a fixed I/O interface, I thought it would be good to let you implement your own particular serial or parallel I/O interface. Taking a look at the upper-left of Fig. 8, you'll find a 25-pin D-shell connector layout and a 20-pin socket layout surrounded by a total of four 20-pin single-in-line pads. With use of the experimenter's breadboard area and using hard-wired or machined-pin connections, you can fabricate just about any type of interface you desire.

A schematic diagram that outlines a

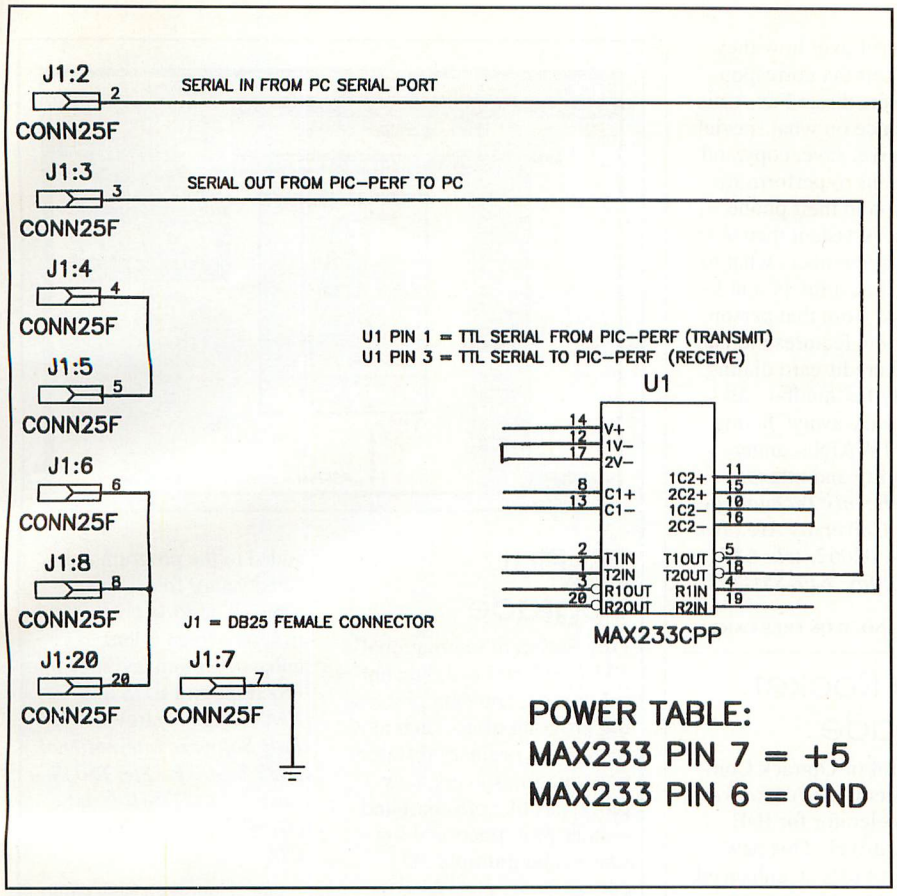


Fig. 9. Typical serial connection for using PIC-PERF breadboarding system.

typical serial interface circuit is shown in Fig. 9. For details concerning parallel-port theory and interfacing, the best offering I've seen is Jan Axelson's "How to Use a PC's Parallel Port for Monitoring and Control Purposes" in the May/June 1994 issue of *MicroComputer Journal*.

PIC-PERF Construction

There's nothing difficult or special that needs to be pointed out about construction of the PIC-PERF breadboard. In fact, you can assemble the PIC-PERF by simply following the printed-circuit board's silk-screen layout shown in Fig. 9. The only "hard wiring" you'll have to do is between the DB-25 connector and serial/parallel interface and providing power (+5 volts and ground) at the specified locations.

I mounted two of the rows of 20-pin headers on the solder side of the PIC-PERF prototype for easier wiring of the DB-25 interface. Be sure to use 0.1-µF capacitors to bypass the power lines on all active components you use. If you choose very small capacitors, you can mount them permanently on the solder side of PIC-PERF. ■

Internet Watch *(from page 99)*

From Prentice Hall...

The Internet CD: Internet Software at Your Fingertips by Vivian Neou. *(Soft cover. 275 pages. CD-ROM. $49.95.)*
This book/CD-ROM package offers a broad spectrum of networking and informational tools to help you get started on the Internet. The CD-ROM contains such tools as *Eudora* Version 1.4 e-mail for PC/*Windows*; the Unix-like *Linux* operating system; *Gopher* search and retrieve utility; INFOPOP and IPWIN Internet information gatherer; WAIS (Wide Area Information Service) Telnet utility for logging onto remote systems; FTP utility for copying files from one host to another on the Internet; Trumpet network support for PCs, UUCP for DOS and *Windows* that includes a newsreader, e-mail and file transfer; and Crynwr Packet Drivers for establishing direct connection to the Internet via the telephone.

The book that accompanies the CD-ROM includes installation instructions, an overview of the software on the CD-ROM and separate sections for DOS, *Windows* and Unix users. As the book points out, most of the software on the CD-ROM is oriented toward experienced computer users. If your PC experience is somewhat limited, you might want to obtain one or more of the above titles as well.

From Van Nostrand Reinhold...

Doing Business on The Internet by Mary J. Cronin. *(Soft cover. 250 pages. $29.95.)*
Written for the non-technical user, this book serves as a fact-filled strategic handbook for information managers, librarians, business people and entrepreneurs. If you feel out of your depth when testing the waters of the Internet, *Doing Business* may be just what you need. It explains the basics of the technology, starting with how to get connected, and goes on to explore the different ways the Internet can be used effectively with case studies of successful business implementations.

Drawing on an analysis of how it's currently being used by more than 100 large and small companies, the author approaches the Internet from a management perspective. She examines the costs and benefits of various business applications and then guides you through the strategies and stages of putting the Internet to work in companies of all sizes, emphasizing practical solutions. Topics include customizing the Internet for product development, business partnerships, research, marketing, entrepreneurial opportunities and customer support. Practical advice is given for businesses on the most-important Internet resources, services and technical developments.

WHAT'S NEW!

(from page 14)

ibility and integration of the product. To meet the need for faster scanning performance, the program's scanning engine was completely redesigned to provide four to five times faster performance. *$129.99. McAfee, 2710 Walsh Ave., Santa Clara, CA 95051; tel.: 408-988-3832; fax: 408-970-9727.*

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CAD/DRAW Upgrade

CAD/DRAW 2.0 for *Windows* is a 2D CAD shareware package from Tommy Software North America. Major new features of this product include the ability to: mark and calculate the intersections of all standard objects; directly edit a selected object and scale, rotate or distort it; change a closed region within a drawing into a closed area; change lines into outlines and polylines into Bezier chains; load a monochrome .PCX file and display it in the background of a drawing. $59.95. *Tommy Software North America, Inc., 130 Barrow St. #516, New York, NY 10014; tel.: 212-807-9720; fax: 212-807-8149.*

CIRCLE NO. 36 ON FREE CARD

Eclipse FAX Upgrade

Phoenix Technologies' *Eclipse FAX* Version 6.0 is a fax software program with new Fax Assistant technology that gives users control over how they manage their fax correspondence. Users direct Fax Assistant just once on what special send, receive, save, copy and OCR options to perform for each person in their phone book. Fax Assistant then automatically remembers what to do every time a fax is sent to or received from that person.

Other new features include expanded credit-card dialing, third-party fax mailbox retrieval, "walk-away" faxing with full TWAIN scanner compatibility and others. $84.95. *Phoenix Technologies, Ltd., 846 University Ave., Norwood, MA 02062; tel.: 617-551-4000; fax: 617-551-3750.*

CIRCLE NO. 37 ON FREE CARD

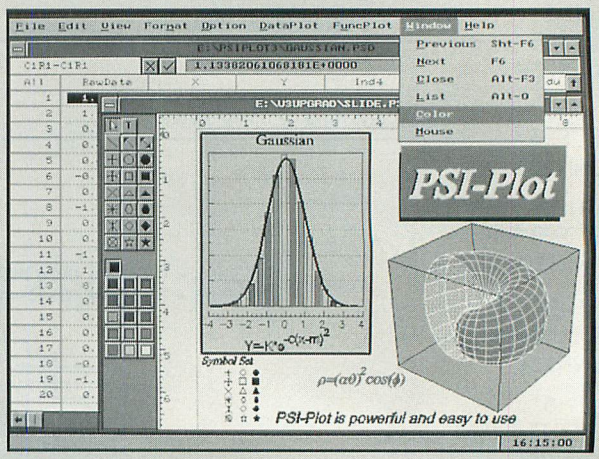
Drive Rocket Upgrade

Version 1.4 of Ontrack Computer Systems' *Drive Rocket* is a data accelerator for IDE hard-disk drives. This new version provides an enhanced FastDisk driver to support *Drive Rocket*'s Read/Write Multiple function. By boosting the rate at which the drive reads and writes data, *Drive Rocket* can significantly increase the speed at which data is processed and permit hard drives to process and transfer data at maximum performance levels. $39.95. *Ontrack Computer Systems, 6321 Bury Dr., Minneapolis, MN 55346; tel.: 612-937-1107; fax: 612-937-5815.*

CIRCLE NO. 39 ON FREE CARD

Simulated Workbench

Interactive Image Technologies' *Electronics Workbench* Version 3 software simulates analog and digital circuits and such test equipment as an oscilloscope and a Bode plotter for spectrum analysis. When a simulated circuit is switched on, the waveforms that appear on the simulated instruments are the same as would be found on a real test bench. The product can be used to design and verify circuits before breadboarding.



PSI-Plot Upgrade

Poly Software International's *PSI-Plot* Version 3.0 technical plotting and data processing program offers such new features as ordinary differential equation solvers, new plot types like pie chart and ternary plot, fractional log scales, and multiple 3D curves in one plot. Also added to the program are filled vector fonts, customized desktop color control, on-screen rulers, enhanced zoom and un-zoom functions and EMS and XMS usage control. $299. *Poly Software International, 3335 S. 900 E., Ste. 150, Salt Lake City, UT 84106; tel.: 801-485-0466; fax: 801-485-0480.*

CIRCLE NO. 38 ON FREE CARD

Version 3 expands the selection of analog and digital parts by adding new components, including JFETs, MOSFETs and controlled sources and switches. Also added are real-world models that make all active components selectable by part number, as in data books. $299. *Interactive Image Technologies, Ltd., 700 King St. W., Ste. 815, Toronto, Ontario, Canada, M5V 2Y6; tel.: 416-361-0333; fax: 416-368-5799.*

CIRCLE NO. 40 ON FREE CARD

Scalable-Font Tool

SizeIt is an MS-DOS and OS/2 productivity tool from Succinct Systems for Hewlett Packard LaserJet 4 and III compatible printers that provides access to built-in scalable fonts for printing text produced by any program, even those that don't support proportional type. *SizeIt* supports all built-in LaserJet III typefaces and 12 of the LaserJet 4's repertoire. $49.95. *Succinct Systems, Inc., P.O. Box 281, Norwich, VT 05055; tel.: 802-649-3711.*

CIRCLE NO. 41 ON FREE CARD

Windows Paint and Animation

Azeena's *Animation Paint Box,* an integrated paint and animation program for *Windows,* comes with several key features that include an onion-skin tool that enables you to simultaneously see current, previous and next frames of an animation for precise alignment of animated objects between frames. Other key features are a rub-through tool that brings underlying objects onto the top screen and a storyboard that displays several frames of an animation at a glance.

The toolbar sports all the standard painting and drawing tools, including free-hand,

curved and point-to-point lines; open and closed rectangles, circles, ellipses and polygons; and customized airbrush, pen-width and resize-able dotted-line tools. All tools can be used from and available palette of up to 16-million colors.

Each mouse button can paint in separate painting modes, including blend, lighten, darken, mosaic, colorize, inverse. Gradient fills can be defined, including directional angles and dither patterns. $300. *Azeena Technologies, PO Box 92169, Long Beach, CA 90809; tel.: 310-988-1889; fax: 310-988-7607.*

CIRCLE NO. 42 ON FREE CARD

AutoCAD Lite

Autodesk's low-cost *AutoCAD LT Windows*-based computer-aided-design package offers a wide range of 2D and 3D drafting capabilities. It provides full data compatibility and seamless interoperability with *AutoCAD* software and offers many of the same 2D design and drafting features of *AutoCAD* Release 12. Its basic 3D features include 2D extrusions, 3D line creation, hidden-line removal, shade, multiple views and the ability to view and edit 3D drawings in the *AutoCAD* .DWG drawing file format. A math coprocessor is required. $495. *Autodesk, Inc., 2320 Marinship Way, Sausalito, CA 94965; tel.: 415-332-2344; fax: 415-491-8200.*

CIRCLE NO. 43 ON FREE CARD

Disk Historian

Solid Oak Software's *Disk Historian* purports to be the definitive solution to wasted hard-disk space. The program maintains a *dBASE III+*-compatible database that contains historical information on file usage for every file on your hard disk. You can view statistical information for each file, such as the date and time of last access, total accesses, age and owner. The program lets you do *ad-hoc* queries and perform such file maintenance as compression, deletion and migration. *Disk Historian* runs under both DOS and *Windows*. $129.95. *Solid Oak Software, Inc., PO Box 6826, Santa Barbara, CA 93160; tel.: 805-967-9853; fax: 805-681-7364.*

CIRCLE NO. 44 ON FREE CARD

Raster Image Processor

Graphx's *RasterPlus/PS* Version. 1.3 is a PC-based raster image processor for driving color film recorders and other high-end output devices. New display list and compiler technologies permit this new version to image large, complex PostScript images as much as 15 times faster than the previous version. Bitmap processing has also been vastly improved.

RasterPlus/PS operates in either the *Windows* or DOS environment and processes TARGA, .TIFF, .GIF, .PCX and SCODL bitmap files, as well as PostScript and EPS files. The new software takes full advantage of Pentium chip technology, with support for register passing, super-scalar compilation and instruction pipelining. $995. *Graphx, Inc., 400 W. Cummings Park, Ste. 3400, Woburn, MA 01801; tel.: 617-932-0430; fax: 617- 932-0855.*

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Multimedia Word Processor

New from Looking Glass Software is *ViperWrite* 2.0, a *Windows*-based hypermedia text processor that uses word-processing capabilities and hyperlinking techniques that let you create and play back full-color interactive presentations. *ViperWrite* includes editing tools to stylize and hyperlink characters, words and phrases to other text, graphics, audio and video files. $199. *Looking Glass Software, Inc., 11222 LaCienega Blvd., Ste. 305, Inglewood, CA 90304; tel.: 310-348-8240; fax: 310-348-9786.*

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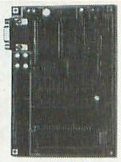

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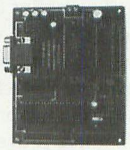

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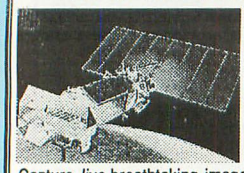

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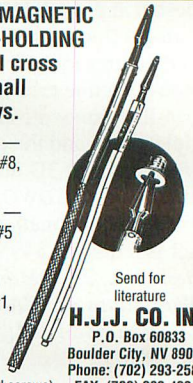

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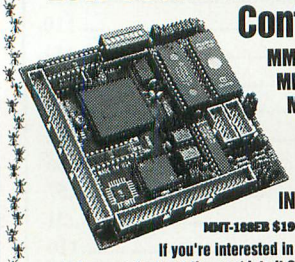

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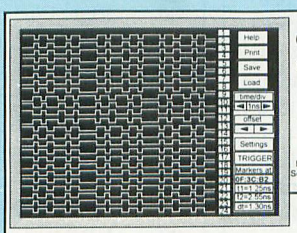

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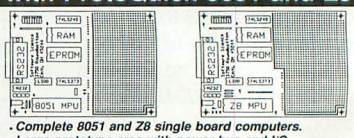

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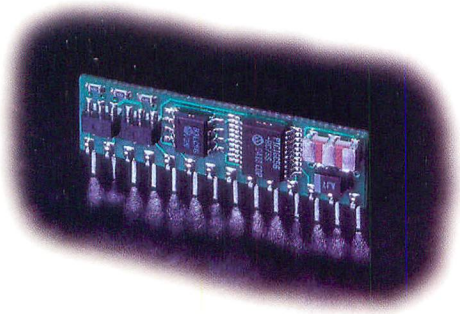

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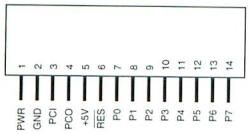

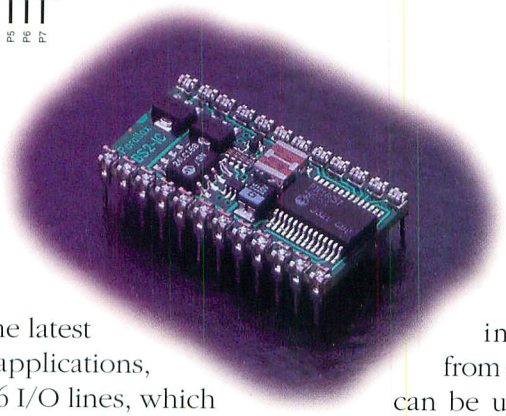

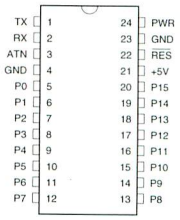

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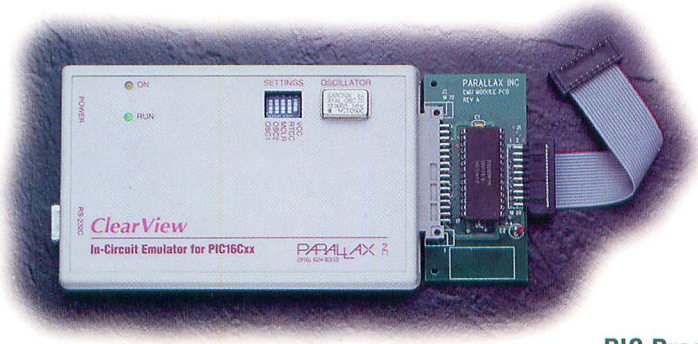

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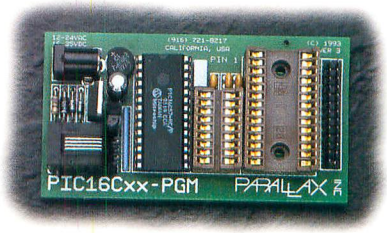

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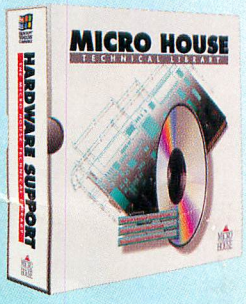

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